

ON THE FOLLOWING .



ESSAYS.

Dr DAVID MACHRYDE, Surgeon.

Printed for A. Millar, in the Strand.

ADOLPH



EXPERIMENTAL

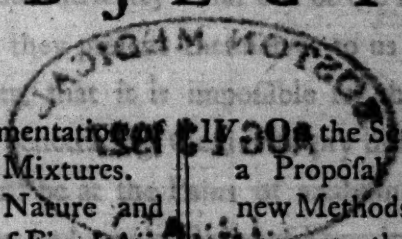
ESSAYS.



EXPERIMENTAL
ESSAYS

ON THE FOLLOWING

SUBJECTS:

- 
- | | |
|--|--|
| I. On the Fermentation of
Alimentary Mixtures. | IV. On the Scurvy; with
a Proposal for trying
new Methods to prevent
or cure the same, at
Sea. |
| II. On the Nature and
Properties of Fixed Air. | V. On the Dissolvent
Power of Quick-Lime. |
| III. On the respective
Powers, and Manner of
Acting, of the different
Kinds of Antiseptics. | |

Illustrated with COPPER-PLATES.

By DAVID MACBRIDE, Surgeon.

LONDON:

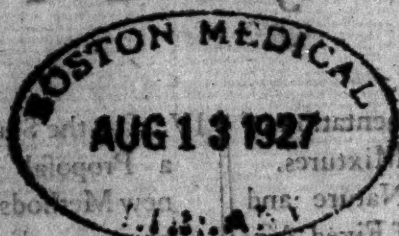
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MDCCLXIV.

EXPERIMENTAL ESSAYS

ON THE FOLLOWING

SUBJECTS:



I. On the Preparation of Alimentary Mixtures.
II. On the Nature and Properties of Fixed and Volatile Acids.
III. On the respective Powers and Manner of Acting of the different Kinds of Antiseptics.
IV. On the Diluents Power of Quick-Lime.

1. M.B. 331

Illustrated with Coloured Plates.

By DAVID MACBRIDE, Surgeon.

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MDCCLXIV.

The wonderful and secret Operations of Nature are so involved and intricate, so far out of the Reach of our Senses, as they present themselves to us in their natural Order, that it is impossible for the most sagacious and penetrating Genius to pry into them, unless he will be at the Pains of analysing Nature by a numerous and regular Series of Experiments; which are the only solid Foundation whence we may reasonably expect to make any Advance in the real Knowledge of the Nature of Things. *Hales.*

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P R E F A C E.

THE general purpose of the following essays is to shew, that there is another principle in matter beside those which are commonly received; and that it is upon this principle, forming the cement, or bond of union, that the firmness, soundness, and perfect cohesion of bodies, chiefly depend.

It

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IT being the author's intention to apply this doctrine particularly to medicine, he begins his investigation by tracing the progress of digestion, and shewing that the principle above hinted at is received into animal bodies by the way of the chyloferous canals; and this makes up the subject of the first essay, and of some part of the second.

THIS point being proved by a number of experiments, and illustrated by some practical observations, he goes on to shew, from experiment also, that animal substances become putrid from the loss of the above-mentioned principle; seeing, that putrefaction is found to arise from the resolution and disunion of
the

The P R E F A C E. ix

the several constituent particles ; and offers a new theory for explaining the immediate cause of that degree of putrefaction, which often takes place in the living body. Here an opportunity is taken of introducing some experiments, in order to determine whether or not putrid animal substances are to be regarded as alkaline : and it appearing from these that such substances are in reality of an alkaline nature, and that some writers of very great note have been mis-led into a contrary opinion, probably from observing that alcalies resist putrefaction ; he then proceeds, in the third essay, to examine, experimentally, the power of antiseptics in general ; and finds that this depends, for the most part, on restraining

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straining the flight of the cementing principle.

AN enquiry then commenceth concerning the power of different things to restore soundness and sweetness to substances already putrid ; and it is shewn, likewise from experiment, that this may be accomplished by restoring the cementing principle.

THIS naturally leads to a consideration of the most effectual methods of curing putrid diseases, which is alleged to depend greatly on the application of such things as are known to be capable of furnishing a large proportion of the principle so often mentioned ; and this is particularly

The P R E F A C E. ixi

cularly exemplified in the cure of the sea-scurvy; a disease wherein the mass of fluids is evidently in a state of putrefaction.

IN consequence of this hypothesis, a proposal ensues for trying new methods to prevent or cure the scurvy, at sea; and this affords matter for a fourth essay, to which is annexed a very accurate account of that most destructive disease, extracted from the writings of JOHN WOODALL, an old English surgeon, whose works seem to be but very little known.

THE fifth essay contains a number of miscellaneous experiments and observations, all tending to a further
proof

xii The P R E F A C E.

proof of what had been advanced in the four preceding ones ; and concludes with laying down easy and expeditious methods of dissolving in water camphor, and all kinds of resinous substances.

THE foundation of the foregoing doctrine having been laid near forty years ago, by the celebrated Doctor H A L E S, and, of late, much improved by Doctor B L A C K, Professor of Medicine of Glasgow, it will be proper that the reader be thoroughly acquainted with the Analysis of Air, in the first volume of Hales's Statics ; and with the experiments on Magnesia, in the second volume of the Edinburgh Physical and Literary Essays ; as also with the experiments

The PREFACE. xiii

ments made by Doctor PRINGLE,
and which are to be found in the
Philosophical Transactions, or in the
Appendix to that learned physician's
Observations on the Diseases of the
Army; the following papers being
designed as a sequel to all the three
writers just now mentioned.

FERMENTATION

ALIMENTARY MIXTURES

ESSAY

THE PREFACE

ments made by Doctor Pringle and which are to be found in the Philosophical Transactions, or in the Appendix to that learned physician's Observations on the Diseases of the Army; the following papers being designed as a sequel to all the three writers just now mentioned, and

which have been sent to the Editor of the Philosophical Transactions, and to the Editor of the Appendix, by Doctor Black, Professor of Medicine at Glasgow, in which it is stated that the reader will be surprised to find that the Author of the first paper has not only written the first paper, but also the second, third, fourth, fifth, sixth, seventh, eighth, ninth, tenth, eleventh, twelfth, thirteenth, fourteenth, fifteenth, sixteenth, seventeenth, eighteenth, nineteenth, twentieth, twenty-first, twenty-second, twenty-third, twenty-fourth, twenty-fifth, twenty-sixth, twenty-seventh, twenty-eighth, twenty-ninth, thirtieth, thirty-first, thirty-second, thirty-third, thirty-fourth, thirty-fifth, thirty-sixth, thirty-seventh, thirty-eighth, thirty-ninth, fortieth, forty-first, forty-second, forty-third, forty-fourth, forty-fifth, forty-sixth, forty-seventh, forty-eighth, forty-ninth, fiftieth, fifty-first, fifty-second, fifty-third, fifty-fourth, fifty-fifth, fifty-sixth, fifty-seventh, fifty-eighth, fifty-ninth, sixtieth, sixty-first, sixty-second, sixty-third, sixty-fourth, sixty-fifth, sixty-sixth, sixty-seventh, sixty-eighth, sixty-ninth, seventieth, seventy-first, seventy-second, seventy-third, seventy-fourth, seventy-fifth, seventy-sixth, seventy-seventh, seventy-eighth, seventy-ninth, eightieth, eighty-first, eighty-second, eighty-third, eighty-fourth, eighty-fifth, eighty-sixth, eighty-seventh, eighty-eighth, eighty-ninth, ninetieth, ninety-first, ninety-second, ninety-third, ninety-fourth, ninety-fifth, ninety-sixth, ninety-seventh, ninety-eighth, ninety-ninth, and the hundredth.

Printed by J. Macdonald, Glasgow.



ESSAY I.

ESSAY I.

FERMENTATION OF ALIMENTARY MIXTURES.

ON THE

FERMENTATION

ALIMENTARY MIXTURES.

E S S A Y

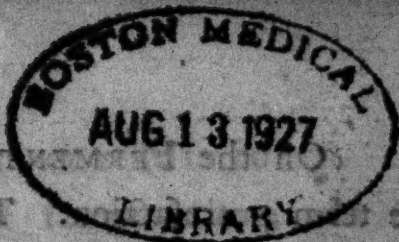
ON THE

*The main business of natural philosophy is to
argue from phenomena, without feigning
hypotheses.*

NEWTON.

OF

ALIMENTARY MIXTURES



ESSAY I.

ON THE FERMENTATION OF ALIMENTARY MIXTURES.

THE old chemists believed, that all the true spontaneous changes, or transmutation of bodies, were the effects of fermentation; but *Boerhaave*, disliking so enormous an extension of terms, restrained it within very narrow limits, and would suffer nothing to be called Fermentation which did not produce either an ardent spirit, or an acid; thus entirely confining it to what are usually called the *vinous* and *acetous* stages, and altogether rejecting the *putrefactive*, as looking on putrefaction to be a quite different process, and no way allied to fermentation.

BUT this restriction, which was meant for the sake of clearness and precision, has rather introduced confusion, with regard to

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the term putrefaction. This word, in its common acceptation, is always understood to imply a plain tendency to destruction in bodies, accompanied with every sign of rottenness and offensiveness: and, accordingly, we often meet with it in writers, in this sense, when perhaps, in the very same page, we shall be told, that the aliment is prepared for nourishing the human body by putrefaction; that motion, life, and heat are communicated to the fluids by putrefaction; and that nature throws off morbid matter from the constitution by the means of putrefaction.

THE later chemists, therefore, who have reduced this branch of natural philosophy to a more intelligible and methodical system, than that of the great man just now mentioned, approach nearer to the ancient opinion, and define fermentation to be an
*“ intestine motion, which arising spontane-
 “ ously among the insensible parts of a body,
 “ produceth a new disposition, and a different
 “ combination of those parts.”* (Macquer.)

FROM this definition it is plain, that a great number of the natural changes which daily take place in the animal and vegetable kingdoms, should be looked on as so
 many

many modes of fermentation; and that, in particular, the digestion of our food ought to be regarded as a fermentatory process.

THE experiments already made by the very learned and ingenious Dr. *Pringle* seem sufficient to convince every unbiassed reader of the truth of this theory; which, if we consider the matter with any degree of attention, we shall find to be absolutely necessary, in order to bring about that new disposition, and that different combination, of the insensible parts of the alimentary substances which enable the immense variety of discordant mixtures, that enter the composition of our food, to depart so far from their original natures as to become one mild, sweet, and nutritious fluid; for this demands a great deal more than mere mechanical mixture and dissolution, which is the most that the common theories * of digestion extend

* Here we must except *Hoffman's* theory; for he insists much on the compleat change that the aliment undergoes in the first passages; and makes digestion a mere fermentatory process; as may be seen at large in

4 On the FERMENTATION of

extend to ; since they do not seem expressly to require, nor indeed suppose, such an absolute change to be wrought, in the first passages, on the nature of the different kinds of food as would render them susceptible of that firm union, and that strong attraction, by the means of which they become, so soon, one and the same substance with the body into which they are received.

It also appears pretty plain, from Dr. Pringle's experiments, that there is somewhat generated, or set free, during the *first stage* of the fermentation of animal and vegetable mixtures, which hath a power of correcting putrefaction. But, in order to obtain still further proofs concerning this particular point, as well as to gain a more thorough knowledge of fermentation in general, I determined to repeat some of the doctor's experiments, and to try such others as I thought had the greatest tendency towards an illustration of both.

his chapter *de Alimentorum Solutione & Salivæ Ufu*, and the three succeeding ones.

To

Y R A T N L A E I I A O I

At the end of 3 hours. At the end of 4 days.				At the end of 3 hours. At the end of 4 days.
Shows no signs of motion.	Shows no signs of motion.	Shows no signs of motion.	Shows no signs of motion.	Shows no signs of motion.
In this experiment, the motion of the piston was not perceptible.	In this experiment, the motion of the piston was not perceptible.	In this experiment, the motion of the piston was not perceptible.	In this experiment, the motion of the piston was not perceptible.	In this experiment, the motion of the piston was not perceptible.
The piston was not perceptibly moved.	The piston was not perceptibly moved.	The piston was not perceptibly moved.	The piston was not perceptibly moved.	The piston was not perceptibly moved.
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Table I. Of A L I M E N T

Mixtures of	At the end of 6 hours.	At the end of 22 hours.	At the end of 30 hours.
(1) Bread and water.	Shews no signs of intestine motion.	Still remains perfectly quiet.	Still at rest.
(2) Bread, mutton, and water.	Fermentation fairly begun; smell of the mixture perfectly sweet.	Fermenting now very briskly.	Brisk; the smell of the mixture perfectly sweet, and a little pungent.
(3) The same, with fresh juice of lemons.	In brisk fermentation; perfectly sweet; smell of the lemon just perceivable.	Very brisk; immersed a small bit of putrid mutton in this mixture.	Brisk; no smell perceivable in the mixture, but a little of putrid mutton, that of the mixture.
(4) The same, with spinnage.	In brisk fermentation; a heavy kind of sweetish smell, not unlike that of the fenugreek seed.	Very brisk; suspended a little bit of putrid mutton in the phial, so as not to touch the mixture.	Brisk; no smell in the mixture, but a little bit of mutton, but not of the mixture.
(5) The same, with water-creffes.	Motion not so brisk as in the two last, but considerably more so than in the simple mixture; smell of the herb but barely perceivable.	Very brisk; poured half an ounce of fresh ox-gall into the phial.	Not so brisk as in the morning; perfectly sweet.
(6) The same, with some putrid animal liquor.	Motion greater in this phial than in any of the others, with a thick scum and froth on the surface; not the least ill smell to be perceived, tho' the putrid liquor was exceedingly offensive when first added.	Very brisk; tho' in the coldest place of all the phials. (Every one of the mixtures were now perfectly sweet, and had lost the peculiar smell of the herbs, &c.)	Brisk and sweet.

ENTARY MIXTURES.

At the end of 30 hours.	At the end of 46 hours	After 54 hours.	At the end of 4 days.
Still at rest.	Still at rest.	Still at rest.	A sourness now perceivable.
The smell of the mixture perfectly sweet and pungent.	Brisk and sweet; much froth at top.	Brisk and sweet.	Fermentation appeared to be now very near over; liquor sweet, both to the smell and taste.
No smell now in the bit of mutton, but the mixture.	Still fermenting; the liquor clear and sweet; removed the bit of mutton and hung it up to dry, it being perfectly sweet.	Motion stopt; the bit of mutton dried and sweet.	Distilled this mixture; an almost insipid phlegm, with rather a vinous, than an acid taste, was the produce.
No smell in the mutton, but that of the mixture.	Fermentation appeared to be almost over; liquor clear and sweet; removed this, and the phial with lemon-juice, to a cool place, and corked them close; hung up the mutton.	Motion stopt; the bit of mutton dried and sweet.	The smell of this mixture, before distillation, was a little inclinable to the cheesy, and the phlegm obtained by distillation had a small degree of pungency, with the same rancid flavour.
Brisk as in the first; perfectly sweet.	Liquor clear and sweet; stopt the phial well, and removed it to a cool place; the mixture tasted a little of the gall.	Motion stopt.	This mixture was sweet, with the fenugreek flavour.
Brisk and sweet.	Still in brisk fermentation, and sweet.	Removed the phial, and stopt it close; fermentation now almost over.	The mixture was now upon the turn; a little sourness just perceivable.

To face page 5.

MIXTURES.

Mixture	After 46 hours.	After 54 hours.	At the end of 4 days.
(1) Mixture at rest.	Still at rest.		A sourness now perceivable.
(2) Mixture sweet; much mutton and	Brisk and sweet.		Fermentation appeared to be now very near over; liquor sweet, both to the smell and taste.
(3) Mixture; the liquor sweet; rest of mutton fresh up to dry, of le	Motion stopt; the bit of mutton dried and sweet.		Distilled this mixture; an almost insipid phlegm, with rather a vinous, than an acid taste, was the produce.
(4) Mixture appeared over; liquor and sweet; is, and the same lemon-juice, spin place, and em close; e mutton.	Motion stopt; the bit of mutton dried and sweet.		The smell of this mixture, before distillation, was a little inclinable to the cheesy, and the phlegm obtained by distillation had a small degree of pungency, with the same rancid flavour.
(5) Mixture and sweet; al well, and same to a cool water mixture taste of the gall.	Motion stopt.		This mixture was sweet, with the fenugreek flavour.
(6) Mixture from fermentation sweet. mal quo	Removed the phial, and stopt it close; fermentation now almost over.		The mixture was now upon the turn; a little sourness just perceivable.

To face page 5.

To fulfil these Intentions, I made up the six following mixtures:

1. Bread and water.
2. Bread and boiled mutton, beat up with the requisite quantity of water.---- This was called the simple fermentative mixture.
3. Four ounces of the simple fermentative mixture, with two drachms of fresh lemon-juice.
4. Four ounces of the simple mixture, beat up with an ounce of spinnage.
5. Four ounces of the simple mixture, with an ounce of green water-creffes.
6. Four ounces of the simple mixture, with two drachms of a very fetid liquor that lay about putrid mutton.

THESE mixtures, being put into phials not closely stopped, were all placed in a moderate degree of heat, on the top of a sand furnace, wherein a retort was at work, on a process which required a continual fire for three or four days.

IN order to have a synoptical view of the progress from time to time, I formed the annexed table, No. I. wherein I minuted down the several appearances, exactly as they shewed at each examination; but the

6 On the FERMENTATION of

general progress of the five mixtures that fermented was as follows :

IN three or four hours the intestine motion was evident ; and soon after all the solid part of the mixtures rose to the top ; bubbles of air, and a thick scum, formed on the surface ; a vapour, with some degree of pungency, and which extinguished fire, now began to discharge itself, and the peculiar smell of the several ingredients having gradually gone off, a sweetish kind of flavour, in some of the mixtures not unlike that of fenugreek seed, succeeded to it ; while the motion becoming very brisk, little pieces of the solid matter every moment fell to the bottom of the phials.

THIS intestine motion continued for the periods expressed in the table ; and by the time that it had ceased, the mixtures were clear, great share of what formerly floated having now fallen down ; they were also perfectly sweet, and such of them as were committed to distillation, sent over a water, or phlegm, with a slight degree of pungency, and of the same sweetish smell of the mixtures, excepting one, that had a little of the rancid, or cheesy flavour.

THUS

Thus we see that the appearances, during the time that these mixtures were fermenting, are exactly like those which attend the working of the sweet vegetable liquors; and the difference seems only to lie in the product of the *first stage*---which we find does not, like these liquors, yield an ardent spirit by distillation; altho' there are some reasons for believing that mixtures of animal and vegetable substances, if fermented together in large quantities, would produce a liquor of an intoxicating quality.

TRAVELLERS of good credit assure us, that there are among the great variety of *Tartar* tribes inhabiting the wilds of *Siberia*, some who have methods of obtaining an intoxicating liquor from milk, which, in all probability, is brought to ferment by the admixture of some putrid animal substance, which Dr. *Pringle* finds (and the same thing may be seen in the foregoing table, at No. 6) to encrease very powerfully the tendency to fermentation, either in milk, or in the common fermentative mixtures. And others of these northern nations make themselves drunk with a most nauseous liquor, made by allowing

8. On the FERMENTATION of

fish and water to ferment in holes dug in the earth, and lined with the bark of the birch-tree.

HOWEVER, until this matter be more fully proved, and that it can be plainly shewn that these mixtures do produce an intoxicating liquor, or an ardent spirit, it will be proper, as well as more clear and comprehensive, to denominate the *three* stages of fermentation, either simply, *first*, *second*, and *third*; or, if it be more agreeable, *sweet*, *sour*, and *putrid*; and characterise them by their several products: The *first*, or *sweet* stage, being two fold, as yielding, 1st. a sweet, agreeably pungent, *inebriating* liquor; or, 2dly, a sweet (*i.e.* sweet, as opposed to sour, and putrid) liquor, which is *not inebriating*. The *second*, or *sour* stage, as turning the subject manifestly sour, and yielding an acid phlegm upon distillation. And the *third*, or *putrid*, when the texture of the substance fermented is fairly destroyed, and having lost its original characters of taste, colour, and smell, it becomes fetid, rotten, and offensive; and if committed to distillation, yields neither an inflammable spirit, nor a sweet phlegm, nor an acid; but a sharp pungent liquor,

liquor, being a solution of a volatile alkaline salt, nearly similar to that salt which may be obtained, by the force of violent heat, from animal substances, without suffering them first to become putrid *.

THIS division, and manner of denomination, will be found to correspond with appearances, and will perhaps comprehend all fermentable substances whatsoever; whereas the terms *vinous*, *spirituous*, and *acetous*, can, with strict propriety, be applied to the fermentation of the sweet vegetable liquors only, which yield, in their

* When it is said, that a volatile alkali may be obtained from putrid substances by distillation, it is to be remarked, that whoever makes the experiment, must not suffer such substances to remain too long before they are distilled, unless kept in close vessels; because the volatile alkali, which is the offspring of putrefaction, is dissipated as fast as it is generated, inasmuch that, at length, nothing is left behind but an insipid water, or a solid matter, being an earth similar to common mould.

And it is in this way, that stinking water, after some time, becomes sweet; the volatile alkali, generated by the putrefaction of the animal and vegetable substances at first contained in the water, being, after a while, entirely dissipated, leaves the remainder without any disagreeable smell.

first

10 On the FERMENTATION of

first and second stages, an inebriating, inflammable spirit, and vinegar.

THE reader, upon looking into the table, will find, that there were two little bits of putrid mutton put into two of the phials, while the mixtures were fermenting; and that these bits of flesh were rendered sweet. This was owing to the action of the vapour, set free during the fermentation; and, as will be shewn at large in another place, the vapour from the sweet vegetable liquors produceth the very same effect.

IT was found, that the vapour from the mixtures agreed likewise in another circumstance with the *Subtile Gas*; as it was termed by the old chemists, namely, that of extinguishing fire; and, I dare say, it would also suffocate animals. But notwithstanding that this vapour, if applied in large quantity to the lungs, might prove so very pernicious, yet it does not by any means follow, that it must necessarily produce the same deadly effect, if pent up in the bowels: We may be very certain that it does not; for if that were to be the case, people would be in very great danger

ALIMENTARY MIXTURES. II

ger after almost every meal they eat, since it is evident, that the vegetables most commonly used as a part of our food, when mixed, either with flesh, or with the native animal juices, actually do raise a fermentation in the first passages, which must of course produce a great deal of this active vapour.

THERE is not sufficient ground, therefore, for acquiescing in a theory which hath sometimes been taught, attributing the sudden death of people who had eaten largely of fruit, or the like, to the action of this subtile spirit, as supposing it to benumb and deprive the nerves of all power and influence.

If this hypothesis were not ill founded, persons in these circumstances, who have been rescued from death by the timely exhibition of an emetic, would not recover themselves so immediately as they are known to do; which shews that the distress must have been occasioned merely by the over distension of the stomach; for had the pernicious vapour once fairly made its deadly impression, emptying the stomach would avail but little; and, if the party recovered at all, it would be but slowly,
and

12 On the FERMENTATION of

and not without much consequent relaxation, and weakness of the paralytick kind *.

THEREFORE, instead of imagining this active and subtile vapour to be productive of any harm in the body, it will appear hereafter, that there are very strong reasons for believing, that it is the *grand preserver* of animal fluids from *putrefaction*; that it attempers acrimony; is a *principal agent* in *nutrition*; and, perhaps, contributes somewhat to animal heat †.

SINCE things of such different natures as bread, lemon-juice, spinnage, and water-creffes, all run with equal facility into fermentation, we might almost venture to conclude that any vegetable, when mixed with an animal substance, and furnished with the requisite quantity of water, will likewise ferment. But to try this matter still farther, in a few days after going thro' the foregoing experiment, I mixed up no less than twenty-one of this kind of mix-

* Vide *Boerhaavii Elementa Chemicæ*, tom. ii. p. 180 & 181.

† Dr. *Pringle* found the thermometer raised three degrees by a fermenting mixture of bread, beef, and saliva; so that there appears to be some ground for this conjecture,

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ALIMENTARY MIXTURES. 13

tures, most of them being in quantity about four ounces; viz.

1. Bread and water.
2. The same, with two drachms of saliva.
3. Bread and water, with green herbs.
4. The same, with two drachms of saliva.
5. Flour and water.
6. The same, with two drachms of saliva.
7. Green herbs and water.
8. The same, with two drachms of saliva.
9. Flour and water, with green herbs.
(The green herbs were spinnage, water-creffes, and onions, equal parts, beat up together.)
10. The simple fermentative mixture.
(i.e. Flesh meat, bread, and water.)
11. Flour and flesh meat, with water.
12. The simple mixture, with about an ounce of green water-creffes.
13. The simple mixture, with an ounce of spinnage.
14. The simple mixture, with an ounce of green onions.
15. The simple mixture, six ounces; lemon-juice, one ounce.
16. The simple mixture, six ounces; fresh wort, one ounce.
17. The

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17. The simple mixture, six ounces ; strong solution of sugar, one ounce.

18. The simple mixture, six ounces ; strong solution of honey, one ounce.

19. The simple mixture, six ounces ; vinegar, one ounce.

20. The simple mixture, six ounces ; brandy, one ounce.

21. A simple fermentative mixture, made with salt beef.

THESE mixtures were all made up at night, and lay fourteen hours before they were placed in a sand bath, where it was intended to have kept up a moderate degree of heat.

THEY were all placed in the sand at ten o'clock in the morning, being then, every one of them, perfectly sweet.----The fire was now ordered to be kindled : In six hours I went to see how things were going on, and was greatly vexed and disappointed to find that the fire, through inattention of the servant entrusted with the care of it, had been made so strong that the mixtures were all in a much fairer way to boil than to ferment. I therefore removed the phials from the sand, and reckoned all this as so much lost labour, not expecting, after having
ing

Table II. Of A L I M E N

MIXTURES of	I.
(1) Bread and water.	No signs of intestine motion.
(2) The same, with about 3ij of saliva.	No signs of motion.
(3) Bread and water, with some green herbs.	No signs of motion.
(4) The same, with 3ij of saliva.	Motion fairly begun.
(5) Flour and water.	No signs of motion.
(6) The same, with 3ij of saliva.	No signs of motion.
(7) Green herbs and water.	No signs of motion.
(8) The same, with 3ij of saliva.	Motion beginning
(9) Boiled mutton, with some green herbs.	No signs of motion.
(10) Bread and boiled mutton, with water.	Motion just perceivable.
(11) Flour and boiled mutton, with water.	Motion fairly begun.
(12) Bread and mutton, with water-creffes.	Motion begun; smell of the herb not perceivable.
(13) The same, with spinage.	Motion begun; smell of the herb not perceivable.
(14) The same, with green onions.	Motion fairly begun; smell of the onion yet strong.
(15) The same, with juice of lemons.	No motion begun.
(16) The same, with fresh wort.	Motion fairly begun.
(17) The same, with sugar and water.	Motion begun; not so brisk as the preceding.
(18) The same, with honey and water.	Motion begun, and as strong as in the mixture with the wort.
(19) The same, with vinegar.	No motion.
(20) The same, with brandy.	No motion.
(21) Salt beef and bread, with water.	No motion.

ENTARY MIXTURES.

	2.
the motion.	Appears not to have stirred at all; sour.
otion.	Appears to have fermented, there being froth at top; now at rest, and quite sweet.
otion.	Had <i>not</i> stirred; smell of the herbs strong.
egun.	Had fermented; now at rest; sweet, of the fenugreek smell.
otion.	Had <i>not</i> stirred; not sour.
otion.	Had fermented; now at rest; smell sweet, like the fenugreek.
otion.	Had <i>not</i> stirred; smell of the herbs strong.
ning	Had fermented; scum on the surface; smell sweet, like the fenugreek.
otion.	Had undergone the fermenting motion, tho' now at rest, the mutton and herbs having all risen to the surface.
ceivable.	Still in motion; great scum at top; smell sweet, like the fenugreek.
egun.	Still at work; the smell perfectly sweet.
nell of the able.	Had wrought briskly; now on the decline; smell of the fenugreek strong.
nell of the ble.	Still at work; smell sweet, exactly like the preceding.
n; smell of ong.	Did not appear to have wrought much; smell of the onion still strong.
gun.	Had fermented; smell of the lemon entirely gone; mixture sweet.
egun.	Not yet quite at rest; sweet; peculiar smell of the wort now lost.
ot so brisk	At rest; sourish, with a little of the cheefey smell.
as strong as h the wort.	Mixture sweet, and at rest; appears to have wrought pretty briskly.
.	Does not appear to have stirred.
.	Does not appear to have stirred.
.	Appears to have wrought, the lighter parts, and much scum, being on the surface; sweet, like the mixture with the fresh meat.

Table II. Of ALIMENTARY MIXTURES.

MIXTURES of		1.	2.
(1) Bread and water.	No signs of intestine motion.	Appears not to have stirred at all ; four.	
(2) The same, with about 3ij of saliva.	No signs of motion.	Appears to have fermented, there being froth at top ; now at rest, and quite sweet.	
(3) Bread and water, with some green herbs.	No signs of motion.	Had <i>not</i> stirred ; smell of the herbs strong.	
(4) The same, with 3ij of saliva.	Motion fairly begun.	Had fermented ; now at rest ; sweet, of the fenu-greek smell.	
(5) Flour and water.	No signs of motion.	Had <i>not</i> stirred ; not four.	
(21) Salt beef and bread, with water.	No motion.	Had fermented ; now at rest ; smell sweet, like the Appears to have wrought, the lighter parts, and much scum, being on the surface ; sweet, like the mixture with the fresh meat.	

(1) Bread and water.

(2) The same, with about 3ij of saliva.

(3) Bread and water, with some green herbs.

(4) The same, with 3ij of saliva.

(5) Flour and water.

(21) Salt beef and bread, with water.

No signs of intestine motion.

No signs of motion.

No signs of motion.

Motion fairly begun.

No signs of motion.

No motion.

2.

Appears not to have stirred at all; four.

Appears to have fermented, there being froth at top; now at rest, and quite sweet.

Had *not* stirred; smell of the herbs strong.

Had fermented; now at rest; sweet, of the fennel greek smell.

Had *not* stirred; not four.

Had fermented; now at rest; smell sweet, like the

Appears to have wrought, the lighter parts, and much scum, being on the surface; sweet, like the mixture with the fresh meat.

ing been so much over-heated, that they would ferment at all. However, in six hours more, I again visited them, and finding some of the mixtures in motion, I marked down the several appearances, exactly opposite to each, as may be seen by looking into the second table, and first column.

BUT as I imagined that the natural course of the fermentation must have been disturbed from the first setting out, on account of the extraordinary heat, I was not very solicitous about a minute and accurate observation of the progress; more especially as I intended to take the trouble of mixing up an entirely new set. I therefore did not go near the place where the phials stood for two days, leaving them all this while in the cold; but going then to examine them, was surprized to find that notwithstanding their being unassisted by heat, yet most of them had fermented, and some of them were still in motion. I therefore minuted down, in the table, the appearances particularly belonging to each, as they stand in the second column.

Soon after this time, I engaged in a course of experiments, with a view of discovering

covering the relative quantity of air, set free from different compounds, and therefore found it unnecessary to repeat all the experiments of the second table, as I had once intended; but at the end of a fortnight I went to the Laboratory, where the phials had been left, and found some of them sour, some putrid, others musty, and some of the mixtures still sweet; but as I had not the table with me, did not minute them down particularly.

Now since it appears, that these mixtures ferment so very readily, even when unassisted by heat, how can there be any doubt but they must run through the same process when they are received into the warm stomach, and are put in motion by the fermentative power of the saliva? which not only the authorities of *Hoffman* and *Boerhaave*, but likewise the experiments just now recited, shew to be possessed of this power in a very eminent degree; as may be plainly seen by comparing the numbers 1, 3, 5, and 7, of the second table, with the mixtures numbered 2, 4, 6, and 8, in the same table.

THE progress of digestion in the human body may be traced in the following manner.

THE

THE food, divided by *mastication*, and mixed with the *saliva*, is fitted for beginning the *intestine motion* very soon after the alimentary substances are received into the stomach; this motion being raised by the temperate warmth of the place, by the remains of the former meal, and by the fermentative power of the *saliva* and *gastric juice*. The first effect of this motion, is, to throw up to the surface the solid part* of the alimentary mixture; which soon again subsiding, the air which buoyed up the solid particles having escaped, the union of these is presently destroyed, and the whole mixed with the digestive fluids; this intimate mixture being much assisted and completed by the agitation caused by the peristaltic motion, by the alternate pressure of the diaphragm and muscles of the abdomen, and by the continual pul-

* Every person must have perceived, at one time or other, that after a hearty meal, if an eructation should by any means be excited, some of the solid part of what had been taken into the stomach comes back towards the mouth. If the meal consisted of a mixture of animal and vegetable food, it is part of the vegetable that always rises; which corresponds exactly with the appearances in the phials, where I constantly observed the vegetable part of the mixture to rise first.

18 On the FERMENTATION of
sation of the neighbouring large blood
vessels.

Thus the aliment passeth on from the
stomach into the *duodenum*, and through
the long tract of the *smaller intestines*;
where having its original nature entirely
changed, by the admixture of the *bile* and
pancreatic juice, but *chiefly* by the fer-
menting motion, which still continues go-
ing on, the several kinds of food are all
blended and mixed together into one mild,
sweet, and nutritious liquor, now in brisk
fermentation, called *chyle*. This *chyle* *.

* That the chyle is a liquor in a state of actual fer-
mentation may be proved from observing the changes
that happen in milk, which is nothing but chyle, a
very little animalized. "The acidity which milk na-
"turally contracts in a few days, must be considered
"as the effect of a fermenting motion, which disco-
"vers in that liquor an acid that was not perceptible
"before; this, properly speaking, being an acetous
"fermentation, which the milk passeth through in its
"way to putrefaction, which soon follows if it be ex-
"posed to a hot air." *Macquer*.

Hence the reason why a diet consisting entirely of
milk is so apt to create a sourness in the first passages;
for being in actual fermentation when taken into the
body, if it be not very soon carried through the smaller
intestines, the second stage will come on. And here
we may perceive the necessity that there is for the agi-
tation and exercise of infants at the breast.

so compounded, is taken up by millions of little absorbent vessels, fully charged with the subtile, active, antiseptic spirit, and conveyed to the *receptacle*; where, and in the *thoracic duct*, it is further mixed with great quantities of *lymph*, and, after no very long course, is poured into one of the large veins, in order to communicate its intestine motion to the blood, to prevent the natural tendency of the fluids to putrefaction, and to repair the waste which our bodies, every moment of our lives, must necessarily sustain.

THE gross, insoluble, and fecal parts of the aliment being thrown off from such as were finer and more nutritious, pass on to the larger intestines; where, at their very first entrance, they meet with a store of sour and putrid ferments, lodged in the *cæcum* and *appendicula vermiformis*, which, in a very short time, convert the alimentary remains into their own nature; and thus communicate a degree of sharpness which must soon stimulate the intestines to a contraction, that ends in expelling these useless and offensive matters out of the body.

ALL this is to be understood of the digestive process, as carried on in persons

who have the happiness to enjoy a perfectly sound state of health ; but in valetudinary people, of weak and relaxed habits ; in pregnant women, whose stomachs, and a great share of the smaller intestines, are thrust out of their natural situations ; and in people whose inclinations or professions oblige them to lead sedentary lives ; the food is often detained so long in the first passages, as to pass on to the *second* stage of alimentary fermentation ; and then it produceth a most austere acid, which however is exactly in the same state with a foreign acid, for the lacteals will admit none of it : It is therefore of necessity accumulated, and proves the cause of sour eructations, heartburning, vomiting, griping, or looseness, according to its quantity, degree of strength, and place where lodged.

THIS sour acrimony, when once established, is not to be removed without some difficulty ; for some of it always lying in the first passages, serves as a leaven to act on every thing taken into the stomach ; and thus, hurrying the alimentary mixture through the first stage, and immediately bringing on the second, renders the food incapable of furnishing a nutritious chyle,

chyle, as not being thoroughly fermented, and also wanting a sufficiency of the true invigorating spirit; all which plainly appears from the paleness and languid disposition of those people who are much afflicted with a sourness in the stomach. And hence the reason why exercise, especially riding, (which agitates the viscera, and prevents the too long stay of the aliment in the first passages) and the aromatic gums and bitters, together with chalybeates, (which produce the same effect, by their stimulating and strengthening qualities) prove so very serviceable in all these cases.

But if the aliment, either from its own very putrescent nature, or from its too long stay within the confines of the smaller intestines, should ever proceed on to the *third* stage of fermentation, it will then become so offensive as to occasion immediate efforts to throw it off, if the quantity of putrid matter be in any degree considerable; but if that should not be the case, it may then remain in the body, and gradually insinuate itself into the mass of fluids, until it accumulates to such a height as to throw the whole system into a confusion,

fusion, which must terminate either in the concoction and expulsion of the offending matter, or in the destruction of the machine itself: For any thing putrid is totally incompatible with the perfect well-being of an animal body; and therefore *Putrefaction* cannot by any means be admitted to a share in the process which is to furnish this body with nourishment and support.

AND here we may remark the admirable œconomy of nature, in guarding so effectually against this hostile putrefactive principle, by so ordering the process of alimentary fermentation, that, of the two first stages, the one should have the property of producing a spirit of such amazing activity that it must pervade the most intimate recesses of the vascular system; and that the other stage should yield an acid, which, if it hath not in itself all the penetrating power of the antiseptic spirit, shall yet be enabled to correct the putrefactive tendency of whatsoever it comes into contact with, and thereby render it mild and inoffensive.

THIS spirit, or vapour, which is set free from the mixtures during their fermentation

mentation in the first passages, which enters the composition of the *chyle*, and with that fluid is transmitted to the *blood*, there to prevent or correct the putrefactive *diathesis*, appears to be chiefly the *Fixed Air* of the alimentary substances; but as this matter cannot be fully explained, nor thoroughly understood, without a knowledge of the properties of *air*, when considered as a constituent principle of bodies, I must reserve the further illustration until it be shewn what those properties are.

NATURE and PROPERTIES

FIXED AIR

ESSAY II.

ESSAY II.

NATURE and PROPERTIES OF

FIXED AIR.

ON THE

NATURE and PROPERTIES

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E S S A Y . II .

ON THE

*May we not, with good reason, adopt this
now fixed, now volatile Proteus, among
the chymical principles, and that a very
active one ?*

HALES,

F I X E D A I R .

ON THE
NATURE and PROPERTIES of
FIXED AIR.

* Boyle's Works, abridged by Shaw, vol. iii. p. 21.

It

IT is therefore to the indefatigable industry of the excellent Dr. *Hales*, that the world is indebted for the discovery that this elastic matter, so nearly resembling common air, is the *principle* which forms the *cement*, or *bond of union*, between the several constituent particles.

BUT although it is now near forty years since this truly useful philosopher published the account of his curious experiments, and thereby opened a new field in natural philosophy, yet the enquiry hath been but little prosecuted; and, excepting *Haller*, there is no systematic writer that I know of, either in chemistry or physiology, who has given that attention to Dr. *Hales's* discoveries which they certainly merit.

THIS celebrated physiologist indeed hath fully adopted the system of *Hales*, and holds air to be the *vinculum elementorum primarium*, the *true cement* which binds together the earthy particles of bodies*.

ALL
* Videtur aer vinculum elementorum primarium constituere, cum non prius ea elementa a se invicem discedant quam aer expulsus fuerit. *Halleri Elem. Physiologiae*, tom. i. in capite primo.

Gluten

ALL the other writers, and *Gaubius*, one of the latest, seem either not to know, or not to believe any thing of this theory; since they make cohesion to depend, altogether, on the attraction subsisting between the particles of elementary earth, exclusive of any other principle. And this very celebrated professor does not so much as mention air, when he is laying down the chemical analysis of the human body*.

BUT it did not occur to these gentlemen, that if *earth* were the *only* cause of *cohesion* in bodies, there *never* could be any

Gluten præstat verum moleculis terreis adunandis, ut constat exemplo calculum, lapidum, aliorum corporum durorum. In iis omnibus solvitur tunc demum partium vinculum quando aer educitur. *Ejusdem Primæ Lineæ*, sect. 244.

* In sicca materie terreum præ aliis cohærentissimum est, atomorum suarum in proximos contactus compactione duritiem daturum vix edomandam nisi aliorum interventu molliretur. Hoc principium cohæsionis, quietis inertię. Et ipsa glutina, terrę quam continent suam cohærentiam debent. *Gaubii Instit. Patholog. Med.* sect. 142 & 143.

But isinglass, and other substances of the like nature, are deprived of the glutinous quality by quicklime; the reason of which will be laid before the reader in the course of these Essays, particularly the Fifth.

change

change in their combination; For “ if all
 “ the parts of matter were only endued
 “ with a strongly attracting power, whole
 “ nature would then immediately become
 “ one unactive, cohering lump; where-
 “ fore it was absolutely necessary, in or-
 “ der to the actuating and enlivening this
 “ vast mass of attracting matter, that there
 “ should be every where intermixed with,
 “ it a due proportion of strongly repelling,
 “ elastic particles, which might enliven
 “ the whole mass by the incessant action
 “ between them and the attracting parti-
 “ cles *.”

It is plain, therefore, that the principle upon which cohesion *immediately* depends must be of a *volatile* or *fugitive* nature, not *fixed* and *indestructible*, like earth; otherwise, the face of this globe would be covered with dead bodies; for when once a stop is put to the life of either animal or vegetable, they become no longer useful in the general system, as organized bodies; and it is then absolutely necessary that their frame should be dissolved, and their elementary particles dispersed, in order to

* Hales's Staticks, vol. i. p. 314.

form nourishment for those beings that yet continue to live.

It will appear hereafter, that the opinions of *Hales* and *Haller* are well grounded; and that the *principle* which is generally known by the name of *Fixed Air*, is the *immediate* cause of cohesion, since the preservation of firmness and soundness in bodies depends on restraining the escape of this *air*; for the moment it *flies off*, and *resumes its elasticity*, we shall see that the other constituent particles, the *earthy*, the *saline*, the *oily* or *inflammable*, and the *aqueous*, being thereby put in motion, immediately begin to exert their several peculiar attractive and repulsive powers, and run into *new combinations*, which first change, and at length altogether destroy, the texture of the substance they formerly composed, provided that this substance contained in itself a sufficient quantity of water to allow of the intestine motion, by giving the proper degree of fluidity*; for without fluidity there can be no intestine

* Here we are not to understand absolute fluidity, but only such a degree of moisture and softness as will allow the several constituent particles to shift and change their places.

motion,

motion, and without intestine motion there can be no change of combination; since we see that such animal and vegetable bodies as are suddenly deprived of their water, or naturally contain very little, are almost as durable and unchangeable in their textures as minerals.

THAT this *air*, which is alleged to be the *cementing principle*, should have the property of passing from a *repellent, elastic* state to the opposite of *nonelastic*, and *strongly attracting*, and *vice versa*, is not easily comprehended; nor indeed could it be believed, if the number of experiments, which prove it, had not put the matter beyond all manner of doubt: So that the fact is as certain as that we breathe air*.

THIS, as well as the property of *elective attraction* in the minute particles of matter, was not unknown to that amazingly comprehensive genius, Sir *Isaac Newton*†; and it was by pursuing the hint of that great man, that Dr. *Hales* engaged in an enquiry which enabled him to establish the theory aforementioned, and which

* See Hales's Staticks, vol. i. p. 293, and vol. ii. p. 279 & 281.

† See Newton's Optics, quest. 30 & 31.

hath been illustrated and confirmed, with regard to a particular class of bodies, by the experiments of Dr. Black*.

BUT there is still a great deal wanting to complete the illustration, which demands a number of accurate experiments; more, perhaps, than will suit the leisure or inclinations of any one person, and therefore must be brought to perfection by the united labours of many.

WITH this view, I began a set of experiments, and resolved to observe carefully the appearances attending the fermentation of such mixtures as usually make up part of our food, and also the appearances which attend the putrefaction of animal substances; hoping from this branch of enquiry to obtain further light concerning some points of very great importance in the animal œconomy.

EXPERIMENT I.

To try the relative quantity of air, set free from different mixtures by fermentation, I put into three phials, marked 1, 2, and 3, first, the simple fermentative mix-

* In his Experiments on *Magnesia*.

ture, about three ounces; secondly, a like quantity of bread and water; and the third phial had nothing but three ounces of common water; these two last being designed as standards.

THE phials, as represented at B, (fig. 1) were placed in a tin pan (A), half full of water, on little pedestals, and covered over with cylindrical glasses (C) of seven inches in height, and three in diameter.

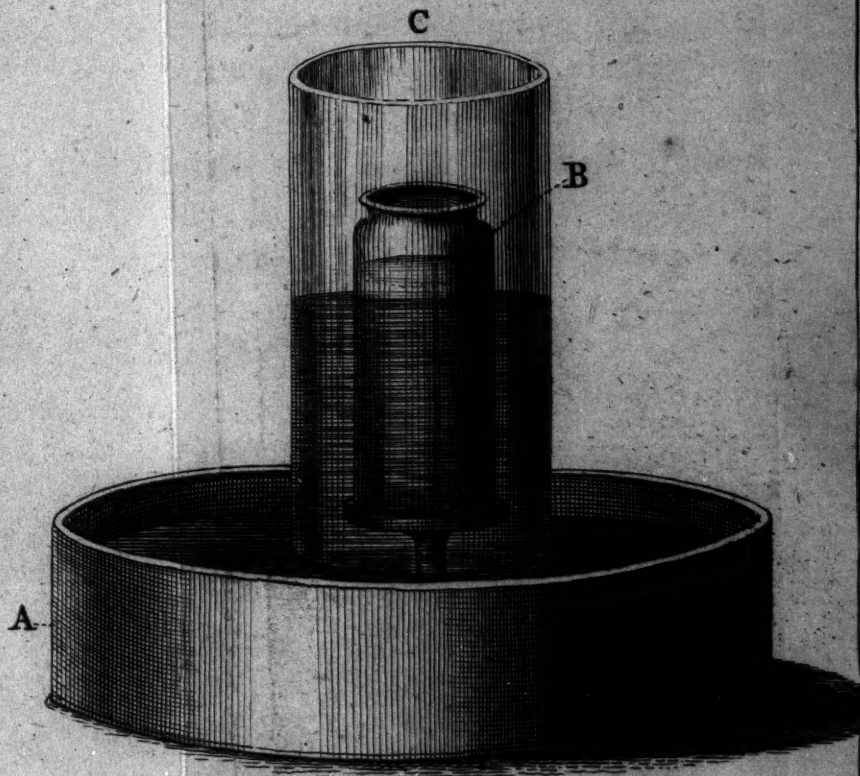
THE air was then drawn out of the cylindrical glasses, by suction through a syphon, so as to raise up the water about half way, and then little bits of paper were pasted on the sides, to mark the rise of the water.

EVERY thing being thus ordered, the whole apparatus was placed before a fire, at such a distance as was sufficient to keep up a moderate degree of heat.

As the heat began to operate, the vapour in each of the glasses expanded itself, and forced down the water to a certain depth, nearly about half an inch; but at the end of eight hours, when the mixture of bread and flesh-meat (No. 1) was in brisk fermentation, the water in its cover was sunk one third more than in the other two, and
in

facing p. 34.

Fig. 1.



in twelve hours it was double, being then a complete inch from the mark.

DURING the night, the whole became cool; the consequence of which was, that the expanded vapour in the glasses 2 and 3 was found in the morning perfectly condensed, the water having returned to its original height; while the air that had been set free from the fermenting mixture (No. 1) still maintained its elasticity, keeping down the water in the cylindrical glass an inch and two tenths.

THE pan was again placed before the fire; and, at six in the evening, the water in the glass belonging to No. 1 was forced down two inches, that in the other two half an inch.

NEXT morning, the vapour being again condensed by the cold during the night, the water stood at an inch and a half from the mark in the fermenting phial, but in the phials No. 2 and 3, it rose to the marks as before.

I placed the whole again near the fire, and the vapour operated as before. On the third morning, the water belonging to the phial No. 2 had returned as usual to the original height; while in the other,

No. 1, it was still kept down a full inch and half, by the force of the extricated air.

I now threw out the bread and water, (from No. 2) and put into the same phial half an ounce of boiled beef cut small, and two ounces of water; and having placed it under the cover, and raised the water by suction, as before, I set it in the pan along with the fermented mixture, which by this time had entirely ceased from working. After standing six hours in the warmth, no elastic air appeared to have been set free from the beef, the water being sunk only half an inch. The other phial (No. 1) now stood exactly at an inch and a half, which, allowing half an inch for the expansion of the vapour, shewed that the mixture had now been for some time in a condition to absorb air, as Dr. *Hales* termed it, for at the same hour the day before the water was down two inches.

On the 4th morning, when all was cool, the fermented mixture was found still to keep down the water near an inch, but in the glass with the beef only the water was up to the mark.

FROM

FROM hence, and from other experiments *, it should seem, that animal substances when alone, and the substance of vegetables when alone, do not part with their air without some reluctance; but that when the two are mixed together, under certain conditions, that then an attraction begins, which presently throws off the air that so closely adhered to each of them in a separate state; and this air, in the moment of its extrication, resuming its elasticity, destroys the union of the minute particles, and, producing an intestine motion, totally changes the nature of the body in which it was fixed, by allowing a new disposition and a different combination, to take place.

AND in this manner is brought about the perpetual transmutation of animal and vegetable bodies, whereby they mutually afford nourishment to each other.

IT has appeared that the alimentary mixtures, though at first they throw off a considerable quantity of elastic air, yet,

* See No. 1 of the first table; and No. 1, 3, 5, and 7, of the second table; and compare them with those mixtures that had either flesh or saliva.

after some time, they *absorb* this air, and again reduce it to a *non-elastic* state.

As the fermentation in the stomach must begin very soon after the aliment is received into it, we may reasonably conclude, that the alimentary mixture will also begin to *absorb* much sooner in the bowels than it appeared to do in the phial; and thus the elastic air, which is set free from the food, will, in great measure, return to a fixt, or non-elastic state, before the chyle enters the lacteals*.

* “ Since we find such great quantities of elastic air generated in the solution of animal and vegetable substances, it must needs be, that a good deal does constantly arise from the dissolving of the aliments in the stomach and bowels, which dissolution it greatly promotes; some of which may, very probably, be resorbed again by the fumes which arise with them.—Thus we see, that the variety of mixtures in the stomach appear sometimes to generate, and sometimes to absorb air. In a true kindly digestion, the generating power exceeds the absorbing power but a little; but whenever the digestion deviates in some degree from this natural state, to generate a greater proportion of elastic air, then are we troubled more or less with distending flatulæ.”

Hales's Stat. vol. i. p. 309.

It has been imagined by a very ingenious gentleman †, that the alimentary substances carry their fixed air into the blood, without its ever having been extricated, or thrown off into an elastic state, during digestion; but this is to suppose, that these substances are never thoroughly broken, nor suffer any change of combination, from the action of the digestive organs; a supposition which cannot by any means be allowed; it being demonstrable (as I humbly apprehend) that the food is intirely broken, and its original nature totally changed, while it is passing through the alimentary canal.

EXPERIMENT 2.

INTO the same three phials which were made use of in the foregoing experiment I put, first, the simple fermentative mixture; 2, the same, with one third fresh lemon-juice; 3, the same, with one third claret.

* Dr. Black. In his *Dissertatio Med. Inaug. De Humore acido a Cibis orto*, he is so far from believing that the aliment naturally ferments in the stomach, that he looks on such fermentation, when it does happen, to be the cause of many, and those very dangerous diseases. See p. 8 and 9 of the *Thesis* above-mentioned.

THE phials were all placed in the pan as before, and the water drawn out by suction. The phial, No. 1, presently began the motion, the solid part all rising to the top; and as it fermented, I found that more air was extricated than there had been from No. 1 of the preceding experiment, which I ascribed to the tenderness of the mutton which was used in this present mixture, as having been longer kept than some beef that I had mixed up for the former trial.

No. 3, with the claret, did not begin to move until it had stood 24 hours; and No. 2, with the lemon-juice, after remaining thirty-six hours, shewed no signs of motion at all; so that here the proportion of lemon-juice was too great; and it appears to have acted as a pure acid, which, as well as fermented liquors, we find restrains the alimentary fermentation.

EXPERIMENT 3.

AT the end of thirty-six hours, I threw out these mixtures, and filled the phials again, with, 1, the simple fermentative mixture, and an ounce of green herbs; *viz.* onions, water-creffes, and garden creffes,

creffes, *aa p. æ.*) 2. The fermentative mixture, with an ounce of lemon-juice and half an ounce of *saliva*; 3. The mixture, with two drachms of very strong rum.

THE mixture, No. 2, with the lemon-juice and *saliva*, began to ferment immediately; and, before two hours were expired, all the solid ingredients had risen; No. 1 began soon after; but it was not till after ten hours, that the mixture with the rum shewed any signs of motion.

HERE we have another strong instance of the fermentative power of the *saliva*, which being compared with those in the second table, plainly shew that *Boerhaave* and *Hoffman* were both in the right, when they ascribed this quality to it.

WHEN the mixture with the lemon-juice had ceased from working, I dropt *Lixivium Tartari* into some of the liquor, but not the least ebullition ensued, which shews, how intirely the fermentatory motion changes the nature of the substance fermented; for here was one third of this mixture, a sharp acid liquor, which would have effervesced violently before the fermentation began; and hence we may conclude, that acids, even independant of their

their mixture and dilution by the native animal juices, must be neutralized by the mere force of fermentation in the first passages, if the digestion proceeds as it ought to do.

IN the mixture with the herbs, the smell of the onion was still very strong, even after the fermentation was over; which agrees with what every body must have perceived, with regard to the fermentation of things of this sort in the stomach; some of this tribe, such as garlick, retain their peculiar smell, even after they have undergone so much of the action of the body, as to become perspirable matter.

ALTHOUGH the mixture with the rum was the latest in beginning, yet, after the motion began, it was more brisk, and finished its career sooner, than either of the other two phials; but not above half the quantity of air was extricated that there was from the simple mixture, No. 1, of the foregoing experiment.

EXPERIMENT 4.

Two of the phials were placed in the pan and covered with the glasses; one having two ounces of a caudle, made of oaten gruel,

gruel, Lisbon white-wine, and sugar, with a little lemon-juice; and the other, the same quantity of the caudle, and two drachms of *saliva*.

THE phial which had the *saliva*, began the fermentatory motion immediately, but it never became brisk, and in about 14 hours intirely ceased; a small quantity of air was extricated at first, but the mixture soon went on to the absorbent state, for by the time that the fermentation had ceased, the water in the cylindrical glass was raised half an inch *above* the mark.

THE other phial without the *saliva* never shewed any signs of motion.

HENCE we see the reason, why this sort of caudle sits so light with people whose bowels are apt to give too much way to distending *flatus*; such as lying-in women, and persons in feverish disorders.

EXPERIMENT 5.

I filled the three phials, 1, with juice of turneps alone; 2, the same juice, with two drachms of *saliva*; and, 3, bread and water, with two drachms of *saliva*, and as much spirit of vitriol as gave the mixture a considerable degree of sharpness, and made

it

44 On the NATURE and
it effervesce smartly upon dropping in *oil of tartar*.

THE phial, No. 2, with the *saliva*, began to shew signs of motion immediately; and, in five or six hours, the simple turnep juice was likewise in motion, and both the one and the other fermented very briskly.

BUT No. 3, though it shewed signs of motion very early, never became brisk; so much had the acid destroyed the fermentative power of the *saliva*. However, what little motion it did undergo, so far altered the state of the acid, that it would not effervesce, upon adding the fixed alkali.

EXPERIMENT 6.

INTO one of the phials I put three ounces of the simple fermentative mixture, and a drachm of the *cortex* in powder; into the second phial I put the same quantity of the mixture, and a drachm of *carraway-seeds* in powder; the third had nothing but three ounces of the mixture, to serve as a standard to the other two.

THE phial with the *bark* began to shew signs of motion as soon as it became warm, and the other, with the seeds, in two hours

hours after; the simple mixture was not in motion till three hours later.

THE *cortex* fermented very briskly, as did also the carraway-seeds; but there was at least one half more air extricated from the latter than from the former, which shews that many of the carminatives may generate air in the bowels, as well as expel it: And if these things were given in large doses, we might account for their action, by saying, that it is the sudden extrication of their air which stimulates the muscular coat of the stomach, and enables it to throw off the offending flatus.

BUT as they are always given, and indeed can only be taken in small quantities, it is upon the hot oil with which these aromatic substances abound, that their carminative virtue depends; for we see that ardent spirits, which neither contain much air themselves*, nor facilitate the extrication thereof from any thing they are mixed with, are yet very powerful carminatives, which must therefore be owing solely to their power as stimulants.

* "I found very little air in 54 cubick inches of brandy." *Hales's Stat.* vol. i. p. 181.

EXPERIMENT 7.

I HAD, on a former occasion, made up mixtures with sugar, wort, and honey, but as the progress of that experiment was interrupted, I resolved to repeat it.

THREE mixtures were made accordingly:

1. Of boiled mutton (without any bread) $\mathfrak{z}$ ss, water $\mathfrak{z}$ ij, and fresh wort, or infusion of malt, $\mathfrak{z}$ ij.

2. The same quantity of mutton and water, with two ounces of a strong solution of brown sugar (about four to one).

3. The like quantity of mutton and water, with two ounces of strong solution of honey.

THESE phials were not placed in the pan, as in the foregoing experiments, but stood in a sand bath, heated by a lamp.

THE mixture, No. 1, with the wort, was the first that began the fermentatory motion, and that very early, in less than an hour after the phial became warm; the sugar began next, about two hours later; but the honey was not in motion until it had stood above eight hours.

I FREQUENTLY shook all these mixtures, and found the fermentation greatly accelerated thereby.

THUS it appears, that honey is not so fermentable, when mixed with animal substances, as sugar; nor sugar so prone to fermentation as the common infusion of malt; and perhaps those disturbances in the bowels, which are often observed in people of delicate and very irritable constitutions, after the use of honey, are occasioned by this refractory quality, since it may lie a considerable time undissolved in the stomach, and there act as a stimulating salt.

UPON the same principle, this may guide us in directing sugar and honey in the diet of sick persons: Where the nature of a disease requires a diet of the most easily fermentable kind, sugar must be preferable to honey; unless somewhat of a laxative nature be likewise demanded, when honey, unless the patient has a peculiar dislike to it, will have the advantage.

EXPERIMENT 8.

WHILE these mixtures were in fermentation, I suspended a little thin bit of very putrid mutton in the neck of the phial with the wort, and left it there during the night;

night; in the morning it was found to have lost the putrid stench, having now no smell but that of the mixture.

EXPERIMENT 9.

I ALSO fixed one extremity of a bended glass tube into the neck of the phial with the sugar, and the other into a little bottle containing a drachm, or thereabouts, of the spirit of *sal ammoniac* made with *quick-lime*, (as represented in the third figure). After they had remained in this situation twenty-four hours, I separated the phials, and dropping in spirit of vitriol on the volatile alkali, found it effervesce very smartly.

AFTERWARDS, I transferred the air from a simple fermenting mixture (*i. e.* Bread, flesh meat, and water) into the same caustic volatile alkali; as I did likewise from melasses wash * in fermentation, and from a mixture of *cortex* and putrid bile, which fermented briskly, and sweetened

* Melasses wash, as it is termed by the distillers, is a liquor brewed from melasses and water, and afterwards fermented by the means of yeast; in order to distil, and make what are usually called sugar-house spirits.

PROPERTIES of FIXED AIR. 40

the putrid gall, all with equal success; in every one of these instances the spirit of *sal ammoniac* effervescing very smartly, after having been supplied with air from the substances in fermentation.

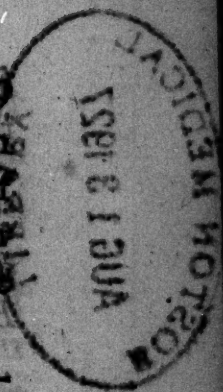
Which shews, that the air set free during the fermentatory process, although it resumes its elasticity immediately upon being thrown off, is yet capable of returning instantly to a fixed state, provided it meets with any substance greedy of air, and which hath a power to receive it.

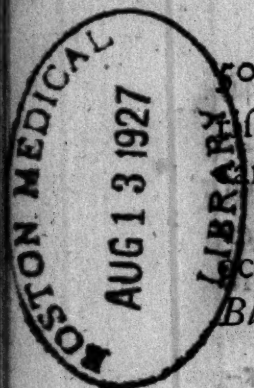
BUT here I find that I have been proceeding rather too fast, unless the reader should happen to be perfectly well acquainted with Dr. *Black's* very ingenious paper on the *magnesia*: if he is, I shall be understood; if not, I shall appear to have talked in a language altogether unintelligible.

IT is sufficiently known, that the *volatile alkaline spirits*, when made by the admixture of *quick-lime* in the distillation, (which they for the most part are, in order to render them more pungent) *do not effervesce* upon the addition of an acid; and that no salt, in a concrete form, ever

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of the phlegm when the process is carried on in this manner.

BUT it was never well understood what occasioned these peculiarities, until Dr. Black published his experiments.

THAT gentleman has shewn very plainly, that *calcareous earths* have a strong degree of *affinity* with *fixed air*, and that in their natural state they abound with it; that by *calcination* they are *deprived* of their *air*; and that it is on account of this deprivation that they acquire so great a degree of *causticity*, and become *soluble* in water; and that, on the other hand, this causticity is destroyed, and the quick-lime rendered *mild*, and *insoluble*, by *restoring* its *fixed air*.

QUICK-LIME, therefore, when joined with *sal ammoniac*, in order to make the volatile spirit, not only detains the *acid*, but likewise the *fixed air* of the crude salt, and thus suffers nothing but the volatile alkali to rise along with the phlegm in the distillation. This spirit, so raised, having *no fixed air* in its composition, cannot effervesce upon the addition of an acid; for effervescence is nothing more than the
fixed

PROPERTIES OF FIXED AIR. 51

fixed air of the mixture flying off, and resuming its elasticity, while the acid and alkaline particles are rushing into close union *; neither can the saline particles of the volatile spirit run together, and form chrystals, because *air* is the *bond of union* in salts †.

NEUMAN imagined, that “ perhaps
“ the quick-lime absorbs, and detains the
“ earthy matter, which is the basis of the
“ volatile salt, and on which its solid form
“ and its effervescence with acids depend.
“ And he relates, that on keeping spirit
“ of sal ammoniac, made with quick-lime,
“ for ten years, it lost almost all its volatility and subtilty, and in this state effervesced strongly ‡.”

BUT there is not the least occasion for waiting so long to produce this change in the nature of the *caustic volatile alkali*, since it may at any time be brought about in ten minutes by transferring the air from some other substance into the *non-effervescent* spirit; as any one may easily satisfy

* Vide Boerhaav. *Element. Chemicæ*, tom. i. p. 531, & tom. ii. p. 398.

† Hales's *Stat.* vol. i. p. 298.

‡ Neuman's *Chemistry* by Lewis, p. 223.

himself by the following exceedingly pretty and conclusive experiment, which is the contrivance of Dr. Black, and communicated by him to my very ingenious friend Dr. Francis Hutcheson, lecturer of chemistry in the university of Dublin.

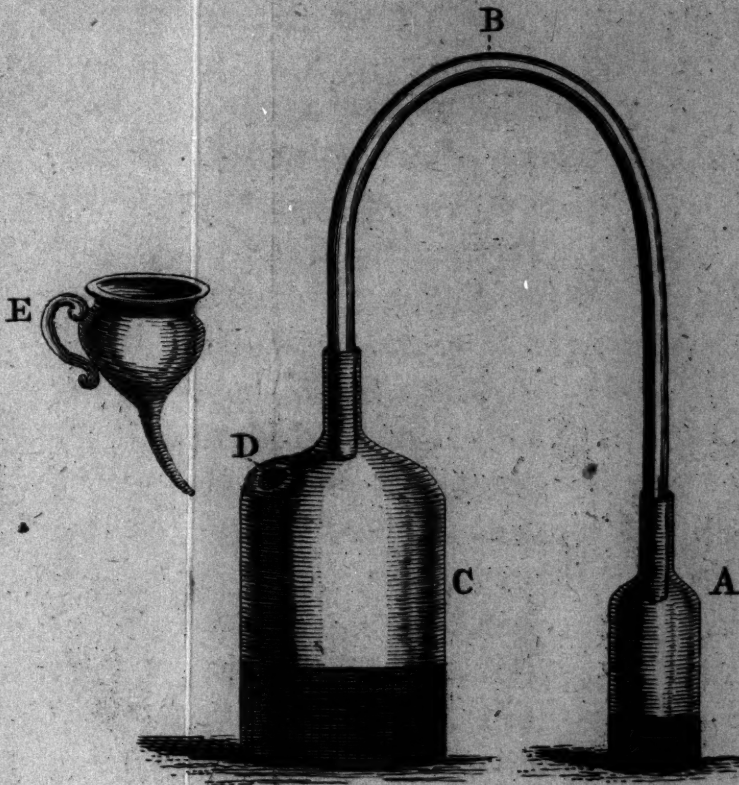
PUT a small quantity of the volatile spirit made with quick-lime into the little phial marked A, in figure 2, and fix closely into its neck, so as that no air may escape, one leg of the bended glass tube (B), and insert the other, and likewise lute it well, into the mouth of a larger phial (C), into which some alkaline salt hath been previously put. This phial must have a little hole drilled in the upper part of it, as at D, that through this aperture, and by means of the small glass funnel (E) an acid may be gradually dropt in.

THINGS being thus fixed, pour in spirit of vitriol, or any other acid, that an effervescence may ensue; and while that is going on, the little hole (at D) is to be stopt occasionally, in order to force over the extricated air into the phial A. An ounce of alkaline salt * expended in this

* Potash is the *alkali* which I generally make use of for this experiment, on account of its cheapness.

facing p. 52.

Fig. 2.



manner will serve to supply a like quantity of *caustic* alkaline spirit with a sufficiency of air to make it effervesce very smartly, when the phials are separated, and an acid dropt into the one which contains the (before) *non-effervescent spirit*.

EXPERIMENT 10.

MANY of the preceding experiments have shewn, in the strongest light, the fermentative power of the *saliva*: I determined, however, to try it once more, and to compare it with the *bile*, in regard to this quality.

I THEREFORE mixed an ounce and half of bread and water, beat up thin, with half an ounce of *saliva*; and the same quantity of bread and water, with half an ounce of *ox-gall*.

THE first mixture shewed signs of motion from the very beginning, and, in less than an hour after it became warm, the motion was brisk; the second, with the gall, was not so soon in motion, it being three hours before the bread had all fairly risen to the surface; but the fermentation continued twice as long, and the motion

was more brisk than in the mixture with the *saliva*.

AND thus it appears very plain that the *bile* has a power, like other animal fluids, to raise a fermentation, when mixed with vegetable substances.

EXPERIMENT II.

Two drachms of boiled mutton, perfectly sweet, were beat up with an ounce of water, and put into one phial; the same quantity of the mutton beat up with half an ounce of *saliva*, and as much water, were put into another phial; and both of them left in the common temperature of the air, which was cool for the season (beginning of June), the thermometer being at 60.

IN thirty-six hours, the contents of the first phial became putrid; the other, which had the *saliva*, remained sweet for forty-eight hours; but both of them fermented; that is to say, an intestine motion took place, the solid part all rose to the surface, and bubbles of air repeatedly formed, and continued discharging themselves, for several hours before any putrid smell was perceivable.

EXPE-

EXPERIMENT 12.

A DRACHM of boiled mutton, perfectly sweet, beat up with an ounce of water, was put into one phial; the same mixture was put into another, and a bit of thread being dipt in some putrid liquor which lay about rotten beef, about the tenth part of an inch of this thread was cut off, and thrown into the phial.

IN twenty-four hours, the contents of the second phial, after undergoing the intestine motion, were found putrid; the first did not betray the least putrid smell until it had stood twelve hours longer.

I REPEATED this with *bile*, and found the phial into which I had put the bit of putrid thread began to smell several hours sooner than the other, which contained *bile* and water only.

THESE experiments confirm the eighteenth of Dr. *Pringle's*, and plainly shew, that bodies in a state of putrefaction are *exciting ferments* to such as are sweet.

EXPERIMENT 13.

IT has appeared from the 6th of these experiments, that the *cortex* ferments very

readily when joined with a mixture of animal and vegetable matters, and even seems to promote that fermentation; but I was desirous to know how it would operate when joined only to the *saliva*.

WITH this view, I mixed up a drachm of the *bark* in powder, with half an ounce of *saliva*, and as much water. At first, there did appear some signs of motion, but they presently went off, and at the end of eighteen hours I found the mixture perfectly at rest, notwithstanding it had stood the first six hours of this time in a moderate degree of heat; for the last twelve, indeed, it had been suffered to cool.

I NOW added half an ounce of *ox-gall*; but no motion ensued till twenty hours more were elapsed: Then I found the solid part getting up to the surface, and the air-bubbles collecting and discharging; but it is to be observed that the phial, all this while, remained in the cold.

FINDING the motion begun, I placed the mixture in a moderate degree of heat, and then the fermentation became extremely brisk, and continued so for twenty-four hours, throwing off great quantities of air; after which it ceased, owing,

as

as I conjectured, to the frequent agitation of the phial, which, as hath been before observed, considerably hastens and shortens the periods of this kind of fermentation.

SINCE this most valuable drug ferments in this manner, when so little assisted by heat, we may safely conclude that it will ferment with very great ease, when lying in the warm stomach, softened and opened by the dissolvent power of the digestive fluids; and, as will hereafter appear, there is good reason to believe that great part of its medicinal virtues depend on this fermentative quality.

EXPERIMENT 14.

IN order to close this series of experiments, I thought it would not be improper to try the several common *farinacea*, and to compare them with each other, in regard to their respective fermentative qualities; as this might be of use in determining which of them are easiest of digestion.

HAVING made up four mixtures, of wheat, barley, oats, and rice, all previously freed from their outward shells or husks, and well boiled, so as to burst the grain,
and

and beat up with the usual proportion of water and flesh meat *, they were then severally put into phials, and placed in a moderate degree of heat, about twelve hours after they were first mixed.

It was not easy to say whether the rice or the barley began first, for both of them were in brisk motion by the time that they had stood an hour in the warmth; the mixture with the oats was not in motion till about four hours after it became warm, and the one with the wheat was three or four hours later than it.

THEY all fermented very briskly, and being often agitated, ran through their first stage in about forty-eight hours.

THUS we may infer, that crude barley † and rice will prove light and easily digestible food; oats next to them; and wheat the most stubborn and indigestible of all. But at the same time we see, that this property in wheat renders it by much the fittest of all the *farinacea* for the making of bread; as it appears to have firmness

* Boiled veal was used in this experiment.

† The barley here used was what is commonly termed pearl-barley.

sufficient to enable it to bear some degree of fermentation in the baking, and yet retain enough of its substance to undergo the alimentary fermentation afterwards in the body.

By this time I had sufficiently satisfied myself with respect to the manner in which digestion is carried on in the human body; being now fully convinced that it is neither more nor less than a true fermentatory process: For since all mixtures of animal and vegetable substances, if furnished with the requisite quantity of water, and kept in the proper degree of heat *, naturally and spontaneously run into fermentation, without the assistance of any *exciting* ferment, how is it possible but that the same kind of mixtures must ferment in the body, when at their very first entrance they meet with a fluid, which, even if their own natures were averse from fermentation, would immediately bring it on? And as they pass farther on, into the *stomach* and *duodenum*, they still meet with more fluids, endued with the same power, in an equal,

* Even heat, we find, is not always necessary; so prone are many of this sort of mixtures to ferment.

or perhaps superior degree: Can it be imagined then, that these substances, when so circumstanced, will not undergo the changes natural to them? and that a fermenting motion will not instantly commence, and continue so long as they remain in a place where they are free to act, uninfluenced by any more powerful ferment; that is to say, so long as they remain within the confines of the *smaller intestines*? But soon after the *valve* of the *colon* is passed, and that the alimentary mixture, which as yet is only in its *first* stage, comes into contact with the *acido-putrefactive* contents of the larger intestines, then is its sweetness destroyed, and it proceeds on to the *second* and *third* stages, and thereby acquires a degree of sharpness and corruption*, which is now become as necessary as it was that the sweetness should continue while the food remained in the first passages.

* It is to be observed, however, that the putrefaction of the *feces alvinæ* is of a peculiar kind; and is never, excepting in some morbid cases, so complete as to furnish a *volatile alkali*, on being committed to distillation.

EXPE-

EXPERIMENT 15.

A DRACHM of salt of wormwood being put into one of the cylindrical glasses described in page 34, and which was used to cover the phials, and an ounce, or thereabouts, of juice of lemons, being poured on the salt, the mouth of the glass was stopp'd, while the ebullition continued, in order to confine the air which was extricated from the mixture.

WHEN the effervescence ceased, a *live sparrow* was thrown into the glass, and in less than half a minute expired.

THUS we see, that the air which is extricated from bodies by effervescence, as well as that which is set free in the first stage of fermentation, and constitutes the *gas sylvestre*, hath the deleterious quality of suffocating animals.

BUT *sal absynthii*, and *succus limonum*, are often given during the act of ebullition, and, I believe there can be no instance shewn of any person's being destroyed by it, notwithstanding what we have just now seen in regard to the sparrow which was suffocated by the vapour arising from such a mixture; therefore, the action of this extricated

tricated or factitious air is very different, when applied *directly* to the *lungs*, and when pent up in the *bowels* of a living animal.

THE fear which the *physiologists* conceived of this deleterious quality in the *subtile gas*, and their not well knowing how to dispose of the great quantities of *air* which must necessarily be thrown off, if the aliment were supposed to ferment, seem to have been the chief obstacles that prevented them from embracing the doctrine of alimentary fermentation.

BUT it seems now proved, that we have nothing to apprehend with regard to the first; and in respect of the latter objection, the experiments above-recited, particularly the 8th, 9th, and 10th, plainly shew, that the air which is set free, either from a *fermenting*, or from an *effervescent* mixture, although it be at first truly *elastic*, yet is of such a surprizing nature as to be capable of returning to a *fixed*, or *non-elastic state*, the moment it meets with any absorbent body that has power to receive it.

AND if we consider that this *air* which is extricated from the food * has the whole

* Sed is etiam aer, qui princeps gluten est partium solidarum animalium, emergit ex intimis, elementa relinquit

extent of the alimentary canal to spread and diffuse itself through, we shall find that it never can create any uneasiness*, excepting when some acrimonious matter, or other stimulus, though more remote, (as in *icteric*, *hysteric*, and *nephritic* cases) occasions a spasmodic constriction in some part of the tube, and prevents thereby the free and equable diffusion of the elastic vapour.

quit absque vinculo. Idem liberatus, diffendit ventriculum magis quam cibi moles. *Halleri Prim. Lin. sect. 632.*

* In habits where the whole system of solids is too much relaxed, whether from intemperance, profuse evacuations, or previous disease, the muscular fibres of the stomach are apt to yield too freely to the elastic vapour, which is thrown off in the commencement of the digestive process, which must necessarily bring on immediate distress, from the over-distension thus created; but the parties thus afflicted generally have recourse to a speedy, though otherwise dangerous, remedy, spirituous liquors: Drams, when swallowed soon after the meal, not only encrease the muscular power of the stomach, but also retard the alimentary fermentation, and thereby give time, before it be far advanced, or that much air is set free, for the food to pass on into the intestines, where the elastic vapour having so much more room to diffuse itself, no uneasiness or oppression will ensue.

ON the contrary, the usual, natural, and gentle degree of distension is of the greatest importance to the animal œconomy; for it stimulates the muscular coats of the stomach and intestines, and thereby excites, and keeps up, their peristaltic motion, and enables the *lacteal*, and other minute vessels, to *absorb* freely; neither of which (the motion nor absorption) could be well carried on, if the sides of this long canal had been suffered to collapse.

THEN, so much of it as is left unabsorbed (for we have seen that the fermenting mixtures, after a certain time, reſorb the air, which at first flies off in an elastic state), entering the composition of the chyle *, it stimulates the vessels appropriated to the carrying of that liquor, and promoting their oscillatory motion, enables them to pour their contents, in a very short space of time, into the general mass of blood.

* It is not by any means intended here to inculcate, that bubbles of air pass with the chyle into the lacteals. What is meant is, that some portion of the air which enters the composition of the chyle, is still in an active, repellent state, and that all the vapour which was thrown off during the fermentation of the food is not as yet deprived of its elasticity.

HERE

HERE the intestine motion is communicated by this active principle, the *elastic air*; while every moment it meets with new powers *, which reduce the requisite proportion to a *nonelastic state*, and leave the remainder in possession of its *elasticity*; which is necessary, to maintain the intestine motion, and to serve as a counterpoise to the pressure of the atmosphere.

I AM well aware, that this assertion concerning *elastic air* in animal fluids is directly contrary to the doctrine of *Boerhaave*, who, in express terms, condemns the theory of *Borelli*, in relation to this matter.

* This is ascribed, by *Dr. Hales*, to the sulphur which is in bodies; and he seems to have been led into this opinion from observing, that the fumes of common sulphur have a prodigious power to absorb and destroy the elasticity of air.

But whether it be in reality the sulphur-principle, or phlogiston, as it is now more generally termed, that has the property of fixing, and reducing to a state of non-elasticity, this air, which we find is thrown off from bodies while they are resolving into their several component parts, cannot possibly be determined from any discovery hitherto made. See *Hales's Stat.* vol. ii. p. 108.

F THAT

THAT great man taught, that the air which is found in bodies of all kinds, and particularly in animal fluids, is there in such a state as to be altogether incapable of acting as air: He thought, that it was divided into such extremely minute parts, that its particles were *solitary*, and that, while they remained in this divided and solitary state, they had no power to exert any of the properties of air; but that when two of these particles came within the sphere of each others action, then they acquired the *repulsive power*, and became *elastic*; and being joined by a third, a fourth particle, and so on, they then burst forth in the form of genuine bubbles of air.

BUT as these particles are kept in their *solitary state* by the weight and compression of surrounding matter, or by the pressure of the atmosphere, and as they never break loose but when the texture of bodies is destroyed, by fire, effervescence, fermentation, or putrefaction; or by removing, almost entirely, the weight of the atmosphere, he contended, that the air in animal fluids, should not be regarded as air; neither should we expect it to exert any of its

PROPERTIES OF FIXED AIR. 67

its usual properties ; seeing that, while life continues, no such changes as those above specified, ever do happen*.

BUT *Hoffman* and Dr. *Hales* are as explicit on the other side of this argument ; and some of the experiments of the latter fully authorize him to be so. His opinion is, “ that there is a considerable quantity of “ air in vegetables upon the wing, and in “ a very active state ;” and that this elastic air invigorates the juices of both animals and vegetables, while it continues in this state of activity†.

INDEED there appears to be an absolute necessity for admitting the existence of *elastic repellent air*, in animal, as well as vegetable fluids ; for, without it, it seems impossible to comprehend how the *intestine*

* *Quin et ratum est, aera latentem in liquoribus, non habere illas vires physicas quas possidet dum extra liquores unitus existit. Igitur in chylo, lacte, &c. adest aer naturaliter, sed ita dissolutus, atque proinde tandiu non agens ut aer. Boerhaav. Elem. Chemicæ, tom. i. p. 519, 524, 525. Corroll. 6, 7, & 8. Vide quoque Prælectiones Academicas, tom. ii, p. 199.*

† See the Experiments in the third chapter of the first volume of the *Statics* ; and also p. 216, 315, of the same volume.

motion can be kept up, or how the canals can be preserved in a constant state of permeability: for as all these canals are more or less flexible, and subject to the pressure of the atmosphere, which is in a perpetual course of variation, if there were not a quantity of *elastic* matter mixed with the fluids contained in them, to serve as a counterpoise to the external air, an entire stop must be put to their circulation; or were this *internal air* in an *unvariable* state, with regard to elasticity, and were it not upon every occasion to preserve the *same tenour* with the *external air*, the sides of the canals must frequently burst asunder. Since even the common changes of the atmosphere, in its usual variation, within the compass of three inches of the barometer, would make such an alteration of pressure as no living body could endure*.

BUT when we are told, that the atmosphere is so light on the tops of exceedingly high mountains, that it is scarce able to sustain a column of *mercury* of sixteen

* This difference is calculated by Dr. *Wainwright* to amount to more than a ton and a half (3982 $\frac{1}{2}$ pounds Troy weight.

inches;

inches*; and so heavy in the bottom of deep mines, that it can support a column of *thirty* inches; and when we know from experience, that a man may *ascend* in the one case, and *descend* in the other, and yet feel no great inconvenience, we may be certain that the *elasticity* of the air in his fluids diminisheth, or increaseth, in the very same proportion that the weight of the air which surrounds him doth diminish or increase; the elasticity of air being always found equal to its density.

AND had not an *equilibrium* been kept up in this manner, the vessels must have burst, in both cases: In the first, because of the expansive force of the air contained

* “ Le Mercure qui se soutenoit dans le vuide au
 “ bord de la mer, à 28 pouces 1 ligne, se soutenoit en
 “ haut, environ 1 ligne au dessous de 16 pouces: les
 “ elasticites de l’air, s’y trouverent encore exactement
 “ proportionelles à ses condensations, de meme qu’en
 “ bas, & qu’en Europe. *Voyage de Mess. Bouguer, &*
de la Condamine, pour determiner la figure de la Terre,
 p. 39.

These gentlemen found the mercury to rise seldom above twenty inches, at the city of *Quito*. At first they felt some uneasiness in their breathing, and such of their company as had weak lungs spat a little blood; but these complaints gradually wore off.

in them; and in the second, by means of the immense weight of atmospheric air pressing upon them. The difference between the weight which presseth on the body of a man in one of the *Newcastle* coal-pits, and what would press upon the same man if he were on the top of one of the *Andes*, being calculated to amount to something about eight tons*.

MANY of the physiologists have imagined, that the animal fluids are furnished

* The mechanical physicians account for this matter by saying, that the impetus of the heart increases as the resistance to the circulating force of the blood increases.

“The weight of the air increasing, the lungs will be more forcibly expanded, and hereby the blood more intimately broken and divided, so that it becomes fitter for the most fluid secretions, such as that of the animal spirits, by which the heart will be more strongly contracted. The blood’s motion to the surface of the body being obstructed, it will pass in greater quantity to the brain, where the pressure of the air is taken off by the cranium, and upon this score more spirits will be separated, whereby the heart will be so strongly contracted as to carry on the circulation through the passable canals, whilst some other are obstructed.” *Wainewright on the unnatural*, p. 92.

with

with air by the lungs; but the objections* against this opinion are such as cannot easily be surmounted; they must therefore be supplied by the way of the *chyliferous canals*, and that in no small quantity; for the air, like all other animal fluids, will require to be perpetually renewed: old particles will every moment fly off, and new ones must of course succeed.

THE air appears to be thrown off by urine, but chiefly by perspiration.

It can be demonstrated that the urine contains much air, but I do not know of any experiment to shew that the perspirable matter contains air; however, I apprehend it may be asserted with great safety, that this fluid, which is the lightest of all animal fluids, is the principal vehicle of the effete and useless air†.

BUT there are many ways of proving the existence of air, in every other part of an animal body.

* They may be seen at large in *Haller Elementa Physiologiae*, tom. iii. and in *Hoffman*, in the chapter *de Sanguinis Circulo per Pulmones*.

† Experiments were afterwards thought of, and made, which demonstrate the presence of air in the sweat and perspirable matter. The reader will meet with them in the fifth Essay.

DR. *Hales* found, that “ a cubick inch
“ of hogs blood, distilled to dry scoria,
“ produced 33 cubick inches of air, which
“ air did not arrive till the white fumes
“ arose.” (*Exp.* 49.)

“ LESS than a cubick inch of tallow,
“ being all distilled over into the receiver,
“ produced eighteen cubick inches of air.”
(*Exp.* 50.)

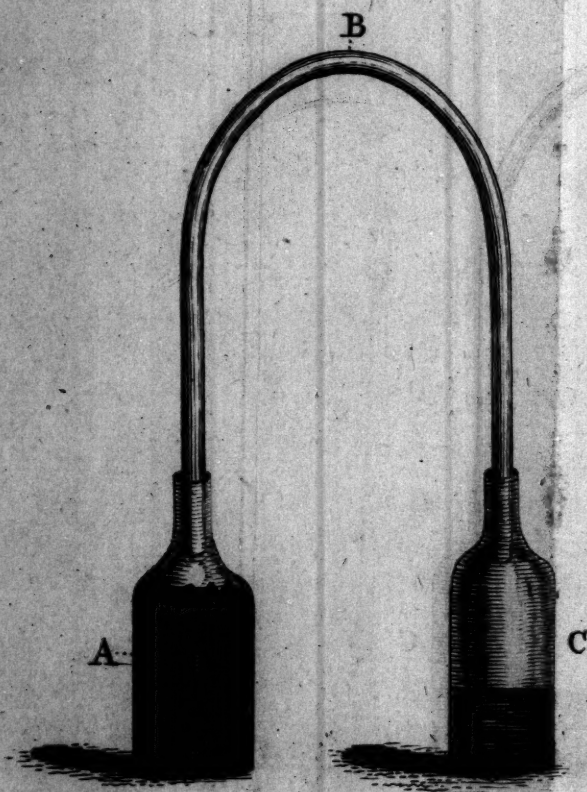
“ HALF a cubick inch of the tip of a
“ fallow deer’s horn being distilled, pro-
“ duced 117 cubick inches of air, which
“ did not begin to rise till the white fumes
“ arose.” (*Exp.* 51.) “ Thus it ap-
“ pears, that the cohesion of animal sub-
“ stances was not dissolved, even in the
“ blood, without considerable violence of
“ fire; though it is sometimes done to a
“ fatal degree, in our blood, by that
“ more subtile dissolvent fermentation*.”

“ SIXTEEN cubick inches of sheep’s
“ blood being put into a bolt-head, with
“ a little water to make it ferment the bet-
“ ter, in eighteen days generated 14 cu-
“ bick inches of air.” (*Exp.* 80.)

* As Dr. *Hales* held putrefaction to be only a degree of fermentation, he therefore useth the terms promiscuously.

facing p. 73.

Fig. 3.



So far Dr. *Hales*; but I was desirous of knowing whether the *fixed air* would pass from a putrefying, animal substance, into the *caustic* volatile alcali, so as to make the said alcali become *mild* and *effervescent*.

EXPERIMENT 16.

IN order to try this, I filled the two-ounce phial (A) fig. 3, with fresh mutton, cut into small pieces, and poured in as much water as served to fill up the interstices; into the neck of the phial, one leg of the bended glass tube (B) was inserted, and closely luted; and the other fixed into a little phial (C) containing about a drachm of the spirit of *sal ammoniac* made with *quick-lime*.

THE phials thus joined together, were hung up in the common temperature of the air. In four days the elastic vapour, in the larger phial, had so expanded itself, that the liquor was raised some inches in that leg of the tube which belonged to it, but upon agitation it subsided: And this agitation I was afterwards obliged to repeat several times, otherwise the putrid liquor would have run over into the small phial.

WHEN

WHEN they had remained in this situation for a fortnight, and that I saw the mutton was become highly putrid, I took off the small phial with the alkaline spirit, and found, upon dropping in spirit of vitriol, that a violent effervescence ensued. So that here was a *demonstration*, that during the progress of putrefaction, there is continually some volatile matter flying off from the putrifying substance, and that this fugitive principle is *air*, which is now extricated, and thrown off, from a *fixed* and *non-elastic* state, into one that is *volatile* and *elastic*; but which, immediately upon meeting with a proper recipient, returns again to its former nature.

WHETHER a communication with the external air be absolutely necessary to the extrication of the fixed air, is a matter in which I am not altogether satisfied: The common notion concerning putrefaction, which is universally taught, and as generally believed, is, that bodies become putrid because that *air* hath *access to them*, and communicates somewhat; and few people seem to have any *idea* that putrefaction ensues in consequence of the *loss* of some principle; which, however, appears to

to be the real cause. For it will be shewn hereafter, that the methods to preserve bodies from putrefaction and decay depend, almost in every instance, on *restraining the flight of the fixed air*; for, as this principle *cements and binds together* the constituent particles of bodies, rottenness, or putrefaction, which consists in the *resolution and disunion* of these particles*, will not take place while the *cementing principle* is present.

BUT, in order to determine somewhat, if possible, concerning this affair, I made the following experiment.

EXPERIMENT 17.

IN the beginning of June, the thermometer being then about 60, I took three little pieces of fresh mutton (of about 3i) one was put into a tea cup, and melted suet poured all around, so as to cover it in-

* We must observe here, however, that to constitute putrefaction there must not only be a resolution and disunion of the several constituent particles, but there must also be a different disposition, and a new combination of these particles; barely withdrawing the fixed air, only destroys the cohesion of bodies. See the 26th experiment of this present Essay.

tirely;

tirely; the second was placed under a cupping glass, which rested upon a piece of wet leather lying on the cover of a book; and all the air that could be exhausted was pumped out of the glass, by means of the little air-pump belonging to it; and the third piece of the mutton was left exposed to the open air of the chamber.

At the end of sixty hours, the piece in the open air, though a good deal dried, was found to have grown evidently putrid. I then went to examine the piece in *vacuo*, and could plainly perceive by its appearance through the glass, that it was become highly putrid, for it had grown mouldy; and upon lifting up the cupping glass, which was now loosened from the leather on which it rested, the smell sufficiently confirmed this appearance, for the putrid stench was by many degrees more offensive and strong than in the piece which had been exposed to the open air.

UPON uncovering the bit of mutton which lay involved in the fuet, it was found perfectly sweet.

EXPE-

EXPERIMENT 18.

I RESOLVED, however, to repeat this experiment, and that with a still greater degree of accuracy and attention; and for this purpose having provided a tight *air-pump*, I took *four* little pieces of fresh beef; the first being weighed, its weight was found to be exactly 458 grains: this piece was placed at eight in the evening (thermometer being at 70) under a small receiver, and all the air that could be exhausted was pumped out; the second piece, weighing 431 grains, was covered with an inverted glass of the same capacity with the receiver, and rested on a piece of wet leather, spread over the bottom of a China plate; the third piece of the beef, which was nearly of the same bulk with the other two, I put into a cup, and poured melted suet all around, and over it; and the fourth piece of the beef was hung up in the open air, on the north side of the house.

WHEN twenty-four hours were elapsed, I took out the piece of beef which had lain in *vacuo*; it had fairly got the offensive putrid smell, and being weighed, was found

found to have lost between seven and eight grains.

THE piece, No. 2, which had lain under cover, was still perfectly sweet, and had lost only two grains and a half.

THE piece in the open air was almost dry, and perfectly sweet.

THE piece covered over with suet was not examined, as I intended it should remain in that situation for some days longer.

HAVING placed No. 1 again under the receiver, and exhausted the air, it was left there till morning; when being again examined, it was found quite putrid, and wanted fifteen grains.

No. 2 had now likewise got the putrid smell, and being weighed, was found to have lost but five grains in all; so that the piece which had lain in *vacuo* lost upwards of $\frac{1}{3}$, while the other wanted only $\frac{1}{3}$ part of its original weight.

THIS loss I looked upon to be chiefly air, for both the pieces appeared and felt as soft and moist as they did at first; and as they had lain both of them upon wet leather, which is but little adapted to absorb watery vapours, I did not imagine that much of the aqueous part could
have

have been exhaled from either ; but the difference of loss between the two must have consisted entirely of air, since the circumstances of both pieces were exactly alike, with regard to the exhalation of their water, both of them being inclosed in vessels of the very same size, and both of them alike excluded from communication with the external air.

THE piece which had been exposed to the open air was found, in thirty-six hours, to have grown perfectly hard and dry ; but was quite sweet, and remained so, being now rendered incapable of putrefaction, by reason of the sudden exhalation of its aqueous part ; for, as hath been elsewhere observed, there can be no fermentation, and consequently no putrefaction, without the requisite quantity of water ; for water, by giving fluidity to bodies, allows the other principles to shift their places, and to exert their several peculiar attractive powers, which they cannot possibly do in a state of too much dryness.

AND hence we see the plain and obvious reason why a moist atmosphere promotes putrefaction ; for, independent of the putrefactive

trefactive *miasmata*, which are sometimes contained in it, and which act upon bodies as ferments, at the same time that the escape of the fixed air is favoured by the smaller degree of pressure, all the water of the putrescent substance is left behind; and even in some cases this very water is increased, which adds to the fluidity, or softness of the body thus exposed.

HAVING suffered the piece which was covered with melted suet to remain untouched for three whole days and a night, I opened it, and found the beef perfectly sound, soft, and sweet; but it grew very putrid in eight or ten hours after it was uncovered, and that a way was made for the fixed air to escape.

EXPERIMENT 19.

I REPEATED this experiment again with two pieces of fresh mutton; the weight of the first piece, which I put under the exhausted receiver, was 573 grains; the other, which was covered by the inverted glass, weighed 554 grains.

AFTER remaining twenty-four hours, I found them both tainted, the weather being at this time very moist, as well as warm;

warm; but upon weighing, the proportion held nearly as before; for No. 1 lost more than five grains, while No. 2 wanted only two.

EXPERIMENT 20.

I THEN took two fresh eggs, which had been laid the same day, and put one of them under the receiver, where it was kept for a week, and the air-pump wrought generally once in the day, in order to keep it as much exhausted as possible; the other egg was left in the open air. At the end of the week, I broke them both, and found the one which had been under the receiver, though it could not be said to be rotten, yet had acquired some degree of *fætor*, and the yolk did not appear near so firm as the one which had been exposed to the open air.

THE broken eggs happening not to be thrown out, I found the one which had been kept in the receiver of the air-pump quite putrid and offensive, on the following morning, while the other remained perfectly sweet.

IT is universally known, that eggs, when coated over with melted suet, or

some such unctuous matter, will remain fresh and sound for many months.

EXPERIMENT 21.

WITH the apparatus belonging to an air-pump, there are generally two hemispheres of metal, contrived to join closely together, so as that when the air is pumped out of the cavity, the two remain firmly united by the mere pressure of the atmosphere.

It did not at first occur to me, that it would be best to inclose the pieces of meat that I wanted to make the experiments on, in this hollow globe, which promised to exclude the external air more effectually than was done in the former way.

HAVING therefore inclosed a piece of sweet and fresh mutton in this sphere, and left another, of the same bulk, under cover of a glass, they were both suffered to remain in those situations for forty-eight hours.

UPON examination, the piece which had been inclosed in the hollow sphere was found sweet, and the other putrid.

THIS being a more complete *vacuum* than any I had been able to make in the glass

glass receivers (for they generally loosened in twelve or fourteen hours) I found that the assertion, "that bodies do not readily become putrid, when perfectly secluded from the external air," may nevertheless be true, notwithstanding what has been seen in the four preceding experiments*; which, however, prove incontestably, that removing the pressure of the atmosphere to a certain degree, does facilitate the escape of the fixed air from bodies; though perhaps a total cutting off all communication between the putrescent body and the external air, may render the flight of this *cementing principle* more difficult†.

DR.

* I am sensible that the experiments above-recited were not made with sufficient accuracy to determine the point in question. The putrescent substances ought to have been inclosed in receivers, cemented to a plate of metal, or glass; and these receivers ought also to have included a mercurial gage. This was the method practised by Mr. Boyle; who relates, that he found oranges, lemons, and four grapes, with their several juices, free from putrefaction or mouldiness, at the end of three years; but a liquor, supposed to be frog's spawn, was found black and fetid at the three years end.

† It was the opinion of Boerhaave, that there is a consent between the atmospheric air and the air inclosed.

DR. *Pringle* having found the *testacea*, and absorbent earths, to be promoters of putrefaction, this seemed the proper time for repeating those experiments.

EXPERIMENT 22.

ACCORDINGLY, I began with chalk, and the *pulv. e chelis cancerorum comp.* of the shops; two phials, each with half a drachm of these powders, mixed with an ounce of water, had severally a small bit of fresh beef put into them; a third phial, with nothing but water and a bit of the same fresh beef, served as a standard.

IN thirty-six hours, the two phials with the absorbent powders had both got the putrid smell; in three hours afterwards, the piece of beef in the third phial became likewise fetid.

in the substance of bodies; and that, as the external air is in a perpetual course of variation, so likewise is this internal air; therefore, when all communication is cut off, the motions of the one are not followed by the other. “Hinc forte fit quod omnes præcipuæ actiones naturales absolvuntur in aere communi non in vacuo Boyleano.” *Elem. Chem.* tom. i. p. 539.

EXPE-

EXPERIMENT 23.

A LIKE quantity of the chalk and *pulvis e chelis* was put into two phials, with an ounce of water in each, and half an ounce of fresh ox-gall. A third phial, with nothing but gall and water, served as a standard.

IN thirty-six hours, the two first phials were found putrid; the third maintained its sweetness for about six hours longer.

EXPERIMENT 24.

HALF a drachm of the earth of allum, mixed with an ounce of water, and a little bit of fresh mutton, were put into one phial; half a drachm of *magnesia alba*, mixed with an ounce of water, and a bit of the same mutton, were put into a second phial; a third bit of the mutton was left in a cup, with common water, for a standard.

IT was about three in the afternoon that these mixtures happened to be made; they were all sweet at bed-time on the succeeding night, after having stood thirty hours; but next morning, the mutton, in both the *magnesia* and the standard, was

found putrid, but the *magnesia* rather more so than the simple water.

THE earth of allum preserved its piece of the mutton twelve hours longer, and rendered it somewhat hard; possibly, some small remains of the acid adhered to the earth, which gave it this slight degree of antiseptic power.

DR. Pringle's conjecture about the manner of operating of these absorbents, is, that they destroy the *latent acid*.

THIS *latent acid* is supposed to enter into the composition of animal bodies, and is conceived to be one of the chief ingredients in the cement between the particles that constitute the fibres; *chalk* and *testacea*, therefore, act as dissolvents, by being the proper absorbents thereof.

THIS *latent* principle, however, is allowed to be so much out of the reach of demonstration, that the doctor says, "It may be hard, or even impossible, to produce it in a simple form."

BUT there is another principle in animal bodies, of whose existence there can be no doubt, the *fixed air*; and *this* makes the *chief* ingredient in the *cement* which binds together the particles that constitute the fibres.

CALCAREOUS earths have a very strong affinity with this fixed air; and though, in a natural state, they abound greatly in this principle, yet from their action of hastening putrefaction, it appears very plain, that they are not so replete with fixed air, but that they are still capable of extracting some from an animal substance, and thereby promoting the intestine motion. For the extraction of *some portion* of the fixed air seems sufficient to throw the remainder of that element into action, and thereby to raise the intestine motion; because, when the fixed air flies off spontaneously from any substance, it always resumes its *elasticity*, or *repulsive power*, in the *instant* of its extrication; and this *repulsive power* it is that puts the other principles into motion.

BUT when the *whole* of the *fixed air* is withdrawn from a body, by any substance having a stronger affinity therewith, such as *quick-lime*, then the *fixed air*, so attracted or absorbed, does *not* regain its *elasticity*, but passeth, in a *non-elastic* state, from one body to another; and hence ensues the *dissolution*, but not the *putrefaction*, of the body whose fixed air is so carried off.

EXPERIMENT 25.

I PUT half a drachm of quick-lime into an ounce of water, and immersed therein a little bit of fresh mutton. This mixture kept off the putrefaction, but it intirely dissolved the flesh, in about a week; not the least ill smell, however, was to be perceived, although I kept the mixture for three weeks in all.

SEEING then, that *dead bodies* become putrid from the *loss* of their *fixed air**,

* I have just met with a book published at *Vienna* in 1762, wherein the author endeavours to establish a very extravagant theory concerning putrefaction and contagious diseases.

He insists, that bodies which are vulgarly supposed to putrefy, or to rot, are devoured by myriads of *animalcula*; that the *fætor* arising from such bodies ariseth from the excrements of the said *animalcula*; and that contagion is spread by their *ova* being waisted through the air, and carried from place to place.

Hence he attempts to account for the appearances in the small-pox, measles, scarlet-fever, and all other contagious or infectious diseases; alledging the cause of all these to be a *materia animata*, or *feminium verminosum*.

The consequence of this theory is, that *mercury*, and the bitter *anthelminthics*, are the only things whereby we are to expect to do service in these diseases. *Marci Anton. Plencix Opera Medico-Physica.*

may

may not the immediate cause of putrefaction in *living* bodies be the detachment of too large a proportion of their *fixed air*?

IN order to see what foundation there may be for this conjecture, let us take a view of the appearances which attend the putrefaction of animal fluids.

DR. *Pringle* remarked, " That both
" the serum and crassamentum of human
" blood yielded air, after standing some
" time in the lamp furnace, before any
" offensive degree of putrefaction was per-
" ceived."

" I HAVE known (says Dr. *Huxham* *)
" the whole body swell vastly, even to the
" ends of the fingers and toes, with a ca-
" daverous lividity, though almost quite
" cold, and an intolerable stench, even
" before the person was actually dead;
" blood issuing at the same time from the
" ears, nose, mouth, and guts: And this
" too where the pulse had been very weak
" and small, though exceeding quick from
" the very beginning. Was not this from
" much air generated by the intestine mo-
" tion, heat, and putredity, which are

* In his *Treatise on the Malignant Sore-Throat*, p. 61.

" well

“ well known to generate air? Is not the
 “ *emphysema* observable in some sphacela-
 “ tions, from the same cause?”

MANY symptoms of this sort, in the
 scurvy, and other highly putrid diseases,
 evidently shew that the air is actually de-
 tached from the blood in these terrible
 cases.

LET us now observe the known causes
 of that degree of putrefaction, which often
 takes place in the *living body*.

FIRST, a long continuance in an *over-
 moist air* is known most certainly to bring
 on the putrefactive *diathesis*.

AN atmosphere full of watery vapours
 obstructs perspiration, not only by lessening
 the force of the relaxed solid fibres, and
 thereby hindering them to propel the usual
 and natural proportion of perspirable mat-
 ter to the surface of the body, but so much
 of this matter as is driven on, when it ar-
 rives at the proper out-lets, finds an *atmos-
 phere already loaded with water*, and conse-
 quently ill adapted, and little capable of
 absorbing much of the same kind of va-
 pour; an animal body, therefore, in this
 state of the weather, may be said to be
 nearly

nearly in the condition of a wet cloth hung out on a damp day.

But the perspirable matter consists of other principles beside water; its taste proves it to contain a large share of *salt*; and the reason of the thing may warrant us in asserting, that it has some portion of *earthy* and *phlogistic*, or oily matter, in its composition; and, in particular, that it carries off a great deal of air *.

The lightest and most fugitive part of this excrementitious fluid, that is, its *aerial* part, may be carried off, notwithstanding the moist state of the atmosphere will not allow the *aqueous* part to be exhaled. A great share of the water, therefore, and the three other principles joined to it, being left behind, now they are deprived of their air, are in a *putrefactive state*, and consequently may be become *ferments* to the remaining mass of fluids,

* Cum totum corpus nostrum innumeris tubulis & poris pervium atque vasculosum sit, per quod, continua & perenni motu, æstuentes humores circumferentur, non mirum est, ingentem copiam tenuissimorum corpusculorum *aqueo-aereorum*, & *sulphureo-salinorum*, modo sub forma vaporum, modo humoris, per illud eveni.

Hoffman. Med. Syst. Rational. pars iii. cap. vii. sect. 11.

IF we attend to the known methods of preserving health, while the body is exposed to too great a degree of moisture, the above hypothesis will appear the more rational; since experience teacheth, that this is most effectually done, 1, by keeping the body well covered, and wearing such kind of apparel as will most readily absorb the watery part of the perspirable matter which the atmosphere cannot absorb; 2, by using such a course of diet as will afford the animal fluids more than usual supplies of air, to make up for the extraordinary waste, such as recent vegetables, fruits, sugar, and aromatics; 3, by eating sparingly of animal food, which yields a small proportion of air, and by abstaining from the *immoderate* use * of ardent spirits and fermented liquors, which check the alimentary fermentation, and hinder the free extrication of air from the substances fed upon.

SECONDLY, if the circulatory motion of the fluids be very much increased, either

* The moderate use of these liquors may be found of service as strengtheners, to encrease the power of the solids, and thus enable them to keep up a due degree of perspiration.

by too violent exercise, or by a fever, and this extraordinary motion be continued, putrefaction most certainly ensues.

It is evident, that the immediate effect of this extraordinary motion and violent agitation of the blood, must be a disunion of its component parts; here then, the *aerial* part will be the readiest to fly off, and will be carried in great quantities to the surface of the body; there it must escape, and when it does escape, we know what must be the consequence*.

THIRDLY, *mercury*, and many of the poisons, destroy the texture of the fluids.

THE action of *mercury* may be considered either as breaking down the particles of the blood by its extraordinary weight, and the force of mere mechanical attrition, or it may be supposed to act in consequence of its having a power to change the natural laws, which obtain among the repulsive and attractive powers of the several

* Hence the propriety of the practice, so much insisted on and recommended by *Sydenham*, in the first five or six days of the small-pox, and in the commencement of putrid fevers; namely, not to overheat the patients, either by diet or medicine, or by suffering them to lie continually in bed.

constituent particles : And this last seems to be the most plausible way of accounting for its operation ; since the quantity of *mercury*, when rendered active by its being joined to some saline body* which is found sufficient to melt down the blood, is so extremely small in many cases, that no mechanical action, arising from its weight, can be deemed equal to the effect. The action of poisons, to which are to be referred infectious *miasmata* causing putrid diseases, cannot well be accounted for, nor any other principle, than by recurring to a power of this last-mentioned kind ; seeing their quantity is so exceeding small, that, let them be supposed to consist of the sharpest of all possible darts or *spicula*, they

* The reason that mercury becomes so extremely active, when joined to saline bodies, I take to be this : It is now rendered capable of the most immediate and intimate mixture with the animal fluids, because of the affinity between water and salt ; and being thus mixed with the mass of blood, can change the repulsive and attractive powers in such a manner as to produce a new combination among the constituent particles.

It is impossible to demonstrate this assertion by experiment ; but a variety of circumstances in chemistry may serve to give an idea of the manner in which it may be brought to pass.

never

never could occasion such alterations, or destroy the texture of the fluids in such a manner, as experience shews may be done, in a very short space of time, by the introduction of these subtile and active matters into the blood.

FOURTHLY, a diet consisting entirely of animal food, excepting in very cold climates *, is followed by a putrefactive dissolution of the fluids.

THE flesh of animals undoubtedly contains oil and salt, of a more sharp and exalted nature than are to be found in the substance of the esculent vegetables; therefore, a diet consisting wholly of flesh cannot fail of producing chyle replete with these acrid principles; but animal food appears likewise to yield but little air, as may be inferred from remarking the structure

* The natives of *Greenland*, together with the *Esquimaux* Indians about *Hudson's Bay*, and many of the *Tartar* nations, feed wholly upon flesh or fish, and some of them do not so much as dress it.

But in these very cold climates, the waste of air by perspiration must be considerably less than it is within the tropics, where it would be impossible to live in this manner for many days without bringing on some putrid disease.

of

of the alimentary canal in carnivorous animals, which is much shorter, has fewer *rugæ*, and does not at all seem adapted to the different degrees of distention, which the stomach and intestines of the creatures who feed altogether on vegetables, or on a mixed diet, are capable of.

It will appear hereafter from experiments, that *air* actually has the power of *correcting* putrid acrimony, when formed; and therefore, it can be no unfair inference to presume, that it has the power to *prevent* this acrimony from taking place: Hence every sort of food, that affords not the due proportion of this element, is always found to promote putrefaction; as many instances in the history of diseases abundantly prove; where some of the most destructive putrid diseases appear evidently to have been occasioned by feeding on damaged vegetables, which are incapable of fermentation, and consequently incapable of producing the requisite quantity of air; for this it apparently is that invigorates the chyle, and enables it to supply good and wholesome blood.

BUT if wanting the due proportion of air be sufficient to induce the putrefactive
diathesis,

diathesis, what must a total want of this salutary principle produce? Accordingly, in those melancholy instances where people have perished through hunger, the humours have been found highly putrid; for the action of the body *dispels* all the lighter aqueous and aerial part, while the oily and the saline are left behind.

THE mechanical physicians think they give a just idea of putrefactive acrimony when they tell us, that it consists in the letting loose of certain sharp pointed particles, which either exist naturally in the fluids (but, in a healthy state, are prevented from doing any harm, by sheaths or *involutra* which cover them); or, that these pointed particles arise from the breaking of the globules, which thus become sharp and angular, like the others before-mentioned; and, like them, are now capable of tearing, irritating, and destroying every thing they meet with*.

THE *soundness* and the *corruption* of animal fluids seem to depend more upon *chemical mixture*, than on *mechanical action*†; and

* Vide *De Gorter de Perspiratione*, in cap. vii. p. 42.

† That is to say, animal fluids do not contain sharp

and yet those chemists who made putrefaction and alcali much the same thing, and, in consequence thereof, were to cure all putrid diseases by acids, have not, by this theory, added much to the true improvement of medical knowledge.

BUT a very eminent practitioner, and admired writer, who has thrown great light on this part of medicine, finding that syrup of violets was not changed to a green colour by the serum of putrid blood; that this serum did not make any effervescence when spirit of vitriol was poured on it; that water, in which corrupted flesh had been sometime infused, neither effervesced nor changed the colour of the syrup; and that alkaline salts, both fixed and volatile, powerfully oppose putrefaction; can by no means bring himself to believe that putrid

pointed or angular particles, that are capable of being obtunded, or brought into the globular form, by merely rubbing against each other in the course of circulation. But these fluids consist of particles which all have their several peculiar affinities, or attracting and repelling powers, with regard to each other, whereby they are capable of forming a great variety of combinations, in a manner similar to what is observable in chemical mixtures.

animal

PROPERTIES of FIXED AIR. 99

animal substances should be regarded as alkaline.

HAVING made several experiments in order to satisfy myself in this matter, I shall here lay an account of them before the reader.

EXPERIMENT 26.

HUMAN blood being left in a phial well corked, at the end of two months was found highly putrid; it had not separated into distinct parts of *serum* and *crassamentum*, but was all alike thick, being of the consistence of syrup, and of a dark red, or rather blackish colour.

SPIRIT of vitriol being dropt into some of this putrid blood, raised a smart effervescence, and converted it into a hardened spongy kind of substance.

EXPERIMENT 27.

Six ounces of this putrid blood being put into a small retort, with two spoonfuls of water, were distilled by a very gentle heat; about an ounce and half of a transparent liquor having come over, the receiver was taken off, and the liquor found to be a phlegm, with a very pungent, and

peculiar fetid flavour, not like that of the blood from which it was obtained, but rather more approaching to the smell of rotten fish.

This spirit effervesced violently, with the acid of vitriol.

It changed the juice of rhadish scrapings to a bright green*.

It threw down a white precipitate, from a solution of corrosive sublimate.

It turned a solution of copper in an acid to a bright blue.

AND when saturated with the acid, and its pungency thereby destroyed, when some fixed alkali was dropt in, the volatile putrid alkali immediately began to fly off, and struck the nose with the peculiar smell, as strong as at first.

So that here are all the plain and distinguishing characters of the volatile alkali.

* The scrapings of radishes afford a blue juice, which answers much better to try acids and alcalies than syrup of violets: The most convenient way is to dip little bits of linnen-rag in the juice, and having dried them, lay them by for use.

EXPE-

EXPERIMENT 28.

WITH regard to the putrid bile, the *factor* here is not at all like, nor indeed so pungent or offensive, as the stench of putrid flesh, or putrid blood; having an oily smell, not unlike stinking olive oil.

PUTRID bile (it was ox-gall that was tried) shews no sign of alcali; it neither effervesce with acids, nor does it change the colour of the blue juices; neither does it throw down any precipitate from the solution of the corrosive sublimate.

EXPERIMENT 29.

TWO ounces of this putrid bile, being distilled by a gentle heat, and two or three drachms of a transparent liquor having come over, the receiver was taken off, and the produce found to be a volatile spirit, with a peculiar fetid smell, and a considerable degree of pungency; this smell differs from that of the putrid bile itself, but approacheth nearly to that of the spirit obtained from the putrid blood, though not so pungent.

BUT this spirit made no effervescence with acids; and when mixed with the so-

lution of the sublimate, it threw down but little precipitate, even less than fresh urine did, when mixed with the same solution; neither did it turn the blue juice to a green colour; so that here there were scarce any signs of an alcali: The only circumstance wherein it manifested the alkaline nature, was when saturated with spirit of vitriol; for when its pungency and *fætor* were destroyed, by the power of the acid, upon adding the fixed alcali, the peculiar smell of the biliose spirit immediately returned.

IT being summer when I was engaged in the above-mentioned experiments, I could not conveniently get any *human bile*, but when winter came on, and the dissections began at the anatomical theatre, I seized the opportunity of collecting a quantity of that fluid; and having suffered it to remain in a corked phial for two months, I then made the following trials.

EXPERIMENT 30.

1. I poured strong spirit of vitriol on some of the putrid bile, but found it raise no ebullition.

HAVING put an ounce of the putrid bile into a little retort, and placed it in a lamp furnace,

furnace, I drew off about two drachms of a transparent liquor, with a considerable degree of pungency, and a fetid disagreeable smell, like the spirit obtained from the ox-gall.

2. Some of this spirit being dropt into syrup of violets, immediately changed the bluish colour of the syrup into a pale green.

3. When dropt into a solution of corrosive sublimate, it instantly threw down a *white* precipitate.

4. And when dropt into a dilute solution of blue vitriol, it caused the solution to grow turbid, and heightened the blue colour.

5. And yet, notwithstanding all these strong tokens of the *alkaline* nature, the effervescence was but very obscure when strong spirit of vitriol was poured on the biliose spirit.

EXPERIMENT 31.

THE putrid liquor which lay about rotten flesh changed the colour of the blue juices to a dark green. It occasioned a small precipitation when added to the solution of corrosive sublimate, but it did not effervesce with the acid, until air was trans-

On the NATURE and
ferred into it, from a mixture of acid and
alkali: This method of treatment, not
only made it effervesce, but also destroyed
much of the putrid factor.

EXPERIMENT 32.

WHEN the factor of this putrid liquor
was destroyed, by pouring vinegar upon it,
it returned immediately, on the addition of
spirit of *sal ammoniac*.

EXPERIMENT 33.

THE same thing happened when the
factor was destroyed by the pouring of
weak spirit of vitriol on the same putrid
liquor, and afterwards dropping in *lixivium*
tartari *.

AND thus we find, that as the *fixed al-*
cali is strong enough to dispossess the *vola-*
tile, so *both* of them have power to expel
the *simple putrid alkali*.

FOR, upon the whole, we may safely
join with *Neuman*, in saying, that as soon
as an animal substance begins to putrefy,

* The acid spirit must here be pretty much diluted,
otherwise it will raise a more disagreeable factor, instead
of conquering the original putrid stench.

it begins to discover an alkaline quality, and this volatile matter, now produced in it, may be separated by distillation in a very gentle warmth.

WHEN I made the experiments on the putrid blood, related in No. 26 and 27, I had not observed Dr. Lewis's note upon the above-recited passage in *Neuman*: and therefore was greatly surprized to find that very ingenious gentleman declare, "That this general doctrine of the chemists did not appear to be strictly just; and that they seemed to have been mis-led by applying to all animal substances what they had found to obtain in one, but what a farther examination shews to obtain in very few, if any besides, at least in any considerable degree."

"PUTRID urine (says he) gives plain marks that it contains a volatile alkali, already generated; but *putrid blood* and *flesh* are not sensibly alkaline, and yield no alkali on distillation, till after the phlegm has arisen*."

AFTER reading this note, from so experienced a chemist, I began to call in

* *Neuman's Chemistry*, in the note, p. 485.

question the evidence of my own senses; and had almost concluded that, some way or other, (though in what I could not possibly guess) the process had been mismanaged.

I THEREFORE determined to repeat it, and that with the utmost caution and exactness.

EXPERIMENT 34.

Two quarts of human blood were put into a retort, which being stopped, was suffered to remain five or six weeks, at the end of which time the blood was found highly putrid; a receiver was now luted on, and the fire raised.

THE very first drachm or two of the liquor that came over was immediately poured out, in order to examine it.

It had precisely the same smell of the spirit obtained in the former process; it *effervesced* with the *acids*, and shewed all the other alkaline properties already mentioned*.

SOME

* The volatile alkali obtained from putrid substances is not exactly similar to that obtained by violent heat from animal substances not putrid.

SOME gentlemen of knowledge in chemistry were present during the distillation, and were all thoroughly satisfied, that in this matter Dr. *Lewis* himself hath been mis-led; and, very possibly, in the same way that Dr. *Pringle* appears to have been; for since *alcalies resist* putrefaction, it was reasonable to conclude, that putrid animal substances were little, if at all, alkaline.

BUT the principle on which this action of *alkaline salts* depends, has nothing to do, in particular, with *alkali*, being, as will be shewn immediately, *common* to all *saline bodies* whatsoever.

It differs remarkably in the flavour, which is nauseous and disagreeable, is not so pungent, and is much weaker, than the common volatile alkali; since this last, as we have just now seen, is capable of dispossessing the putrid alkali, and of driving it off from any body to which it hath been united.

Some gentlemen of knowledge in chemistry were present during the distillation, and were all thoroughly satisfied, that in this manner Dr. Priestley himself had been misled; and, very possibly, in the same way that Dr. Priestley appears to have been; for since alkalies will putrefaction; it was reasonable to conclude, that putrid animal substances were little, if at all, alkaline.

But the principle on which this action of alkaline salts depends, has nothing to do, in particular, with alkali, being, as will be shown immediately, common to all Salts.

It differs remarkably in the flavour, which is pungent and disagreeable, is not so pungent, and is much weaker, than the common volatile alkali; since this salt, as we have just now seen, is capable of dissolving the putrid alkali, and of driving it off from any body to which it has been united.

It is also very remarkable, that this salt, when mixed with water, does not form a precipitate, as the volatile alkali does, when mixed with water.

ESSAY III.

ON THE RESPECTIVE POWERS, AND MANNER OF ACTING

Of the different Kinds of

ANTISEPTICS.

Although the arguing from experiments and observations by induction, be no demonstration of general conclusions, yet it is the best way of arguing which the nature of things admits of; and may be looked upon as so much the stronger, by how much the induction is more general. NEWTON.

ESSAY III.

ON THE

RESPECTIVE POWERS, and MANNER of ACTING, of the different Kinds of ANTISEPTICS.

IT was never imagined, until Dr. *Pringle* shewed it, that the *Antiseptic Power* is so extensive; but it appears from the experiments made by that very judicious and learned physician, that *salts of every kind*, whether *acid, alkaline, or neutral, fixed or volatile*, as well as the *astringent and gummy-resinous* part of vegetables, all of them resist, and most of them correct putrefaction; and he pursued this branch of enquiry so far as to enable him to form a table, shewing the comparative antiseptic forces of these several substances.

HIS being so very particular on this head rendered it unnecessary to repeat the experiments, with regard to all these different

ferent substances; but as I had got into the habit of experimenting, and found great satisfaction from this method of acquiring knowledge, I resolved to try some of them; and accordingly began with the *acids*, which, from ancient prescription, claim the right of being placed at the head of this class.

EXPERIMENT I.

HAVING diluted the *acids* of *vitriol*, of *sea-salt*, and of *tartar*, together with *vinegar*, and the *juice of lemons*, all, as nearly as I could judge, to the same degree of weakness, leaving them just so strong as to be fairly sensible to the taste, as to change the blue juices into red, and to effervesce plainly, upon the addition of an *alkali*; I then put some ounces of each into *five* phials, and in every one of them immersed a little bit of fresh mutton; and a sixth phial, with nothing but water and a bit of mutton, served as a standard.

THEY were all placed in a moderate degree of heat (on the top of the furnace, along with the fermenting mixtures of the second table) and suffered to remain for four days.

It

Table III. ACIDS diluted tried as ANTISEPTICS.					
ACID S.	24 Hours.	AFTER STANDING 48 Hours.	3 Days.	4 Days.	
(1) of Vitriol.	Sweet.	Sweet.	Sweet.	Sweet.	
(2) of Sea-salt.	Sweet.	Sweet.	Sweet.	Sweet.	
(3) of Tartar.	Sweet.	Sweet.	Beginning to putrify.	Putrid thrown out.	
(4) of Vinegar.	Sweet.	Sweet, and much swelled.	Sweet.	Sweet.	
(5) of Lemons.	Sweet.	Sweet, and much swelled.	Sweet.	Sweet.	
(6) Water, as a Standard.	Smell grown offensive.	Very fetid.	Putrid, and soft.		

IT appears by the foregoing table (the 3d), that they were all, excepting the one in the *acid of tartar*, and the standard, sweet at the end of four days. I hung up all the sweet pieces in the open air, where they soon became dry, and remained sweet.

THUS it appears that acids, even when greatly lowered, have a strong degree of power to resist putrefaction.

EXPERIMENT 2.

ALONG with this parcel of *acids*, I tried the *fixed* and *volatile alcalies*, diluted to the same low degree; but though the *volatile alcali* preserved the piece of mutton immersed in it, as well as any of the *acids*, yet the *lixivium tartari* did not keep its sweetness much longer than the simple water which served as a standard.

I RESOLVED, therefore, to try the *alcalies*, without lowering them so much; and, at the same time, was desirous of seeing what share of *antiseptic power* was possessed by a *neutral* mixture.

EXPERIMENT 3.

FIVE bits of fresh mutton were put into as many phials, with, 1, *lixivium tartari*;
2, *spirit*

POWERS OF ANTISEPTICS. 113

2, *spirit cornu cervi per se*; 3, *spirit salis ammoniaci cum calce viva*; 4, *spiritus mindereri*; and, 5, *water*, as a standard.

THE four first were all diluted with water, in the proportion of four to one; and all were left in the common temperature of the air.

THE phials were examined every day, for eight days; and all of them, the standard excepted, which grew putrid in three days, found sweet; the pieces of mutton in the *alkalies*, grew soft and white, like fresh fish; but the one in the *spiritus mindereri* always preserved the natural redness of the flesh.

I NOW left off examining them every day, and having laid the phials aside for three weeks, found all the bits of mutton as sweet as they were on the first day.

THE power of the saline bodies was also tried, in another manner.

EXPERIMENT 4.

I PUT four pieces of fresh mutton into as many cups, and poured on them severally, 1, *weak spirit of vitriol*; 2, *spirit of hartshorn*; 3, *lixivium tartari*; and, 4, a *neutral mixture*, of *fixed alkali* and *vitriolic acid*;

acid; and having suffered them all to remain about ten minutes, by which time they appeared to be thoroughly soaked and penetrated, I then threw them all into glasses with water, and set them by, in the common temperature of the air. The annexed table, No. 4, shews how long each of them preserved their sweetness.

Thus the power of *salts in general*, to keep off putrefaction, was most satisfactorily proved; and as this power belongs to saline bodies *in general*, it certainly must depend on some property which is *common* to them *all* as *salts*, since we plainly see that *acid* and *alkali* have nothing to do here.

With regard to *astringents*, Dr. Pringle's experiments shew them to be possessed of a very great degree of antiseptic virtue; for *allum*, *galls*, *green tea*, and *red roses*, were all found to resist putrefaction, with a power greatly superior to *sea-salt*.

AND the *gum-resins*, such as *myrrh*, *asa foetida*, *aloes*, and *terra japonica*, together with decoctions of such vegetable substances as abound in *gummy-resinous* parts, *virginian snakeroot*, *pepper*, *ginger*, *saffron*, *coutrayerva root*, *sage*, *valerian root*, and *rhubarb*, with *mint*, *angelica*, *senna*, and
common

Table IV. SALINE BODIES as Opposers of Putrefaction.

Spirit of Vitriol.	Spirit of Hartshorn.	Lixivium Tartari.	Neutral Mixture.	Water, as a standard.
Remained sweet 28 Days.	Remained sweet 8 Days.	Remained sweet 4 Days.	Remained sweet 14 Days.	Was putrid in 36 Hours.

common wormwood, all of them shewed great antiseptic power; but none of them came up to *camphire*, in this respect, which Dr. *Pringle* thinks may be allowed to keep off putrefaction, with a power *three hundred* times greater than *sea-salt*.

MANY of the common esculent vegetables, *horse radish*, *mustard*, *carrots*, *turneps*, *garlic*, *onions*, *celery*, *cabbage*, and *colewort*, were likewise found to keep back putrefaction.

BUT I do not know how it happened to Dr. *Pringle* *, that he should find *lime water*, “ only, to make some small resistance to putrefaction,” since *lime-water* has been universally known, to be very powerful in this respect; and the late Dr. *Alston*, who was a man of very great candour and veracity,

* See his 27th experiment.

Dr. *Pringle*, however, may be justified in not allowing *lime-water* to be an antiseptic; for, in order to constitute a true antiseptic, it is not only requisite that there be a power to prevent the intestine motion, but also to preserve the firmness and cohesion. Now *lime-water*, though it prevents the intestine motion, and consequently hinders the generation of the putrid alkali, yet, by absorbing the fixed air, it destroys the cohesion of the constituent particles.

relates

relates a number of experiments, in his Dissertation on Quick-lime, which put the matter beyond all possibility of a doubt; so that I am inclined to think, either, that Dr. *Pringle* cut his pieces of flesh so large that the lime-water could not penetrate them, or that his lime-water has been made from shells, or chalk, not thoroughly calcined, which might have given the water a disagreeable smell, that was mistaken for the putrid *fætor*.

EXPERIMENT 5.

IN order to satisfy myself in regard to this matter, I put a bit of fresh mutton, of two drachms weight, into an open glass, containing some ounces of *lime-water*: It was left there for a fortnight, and at the end of that time was found perfectly sweet; it had indeed grown quite tender, and when it was cut into, and some *spirit of vitriol* dropt on it, an effervescence ensued, from the particles of the *quick-lime*, which had penetrated the substance of the flesh, and *there* being saturated with the *fixed air*, were now returned to their original state of a *calcareous earth*.

THIS circumstance of the effervescence, will, if I mistake not, lead us to the *true theory* of the *antiseptic power*, and will shew us on what it immediately depends.

WE have seen, by the 17th experiment of the preceding essay, that putrefaction ensues in consequence of the *escape* of the *fixed air*; therefore, whatsoever hath the power to *restrain* the flight of this element, or *binder* the *intestine motion*, will *prevent* putrefaction.

CALCAREOUS *earths*, in their native state, have a strong *affinity* with *fixed air*, and we have seen, that upon this account, when they lie in contact with an animal substance, they attract some of this element, and thereby accelerate putrefaction: For here they *cannot penetrate* the substance of the putrescent body; they only *surround* it: But when these earths are calcined, and converted into *quick-lime*, then a certain portion of them is rendered *soluble* in *water*; the earthy particles, thus minutely divided, are *now* capable of *pervading* the soft texture of animal and vegetable bodies; where, as hath been just now seen, they immediately join themselves to the *fixed air* of those bodies: So long therefore,

as the particles of *lime* remain in this situation, so long will the *fixed air* remain in a non-elastic state, and so long will the intestine motion, and that particular combination of the insensible parts which constitutes putrefaction, be kept at a distance.

ALL *saline* bodies * have a strong *affinity* with *fixed air*; and likewise *resinous bodies* † are most *tenacious* of *fixed air*, for they are only soluble in water when deprived thereof; and hence the *antiseptic virtue* of all these substances; for they are all of them capable of such extremely minute division, that their particles can most easily pene-

* “ For since upon the dissolution of the constituent parts of salt by fire, it is found, upon separating
“ and volatilizing the acid spirit, that the air-particles
“ do in great abundance rush forth from a fixed to an
“ elastic state, it must needs be that these particles did,
“ in their fixed state, attract the acid spirits.” *Hales*,
vol. i. p. 294.

See also *Boerhaav. Elem. Chemiæ*, tom. i. p. 531; where there are further proofs that salts have a very great affinity with, and are very tenacious of, fixed air.

† That is to say, completely soluble; since we find that some portion of the resinous part of vegetables dissolves in water, by means of its strict union with the gummy or mucilaginous part.

trate

trate into any animal, or vegetable body, and *there*, immediately join themselves to the *fixed air* of those bodies, *where* remaining, they do, like the lime, when divided and dissolved in water, keep back putrefaction by *preventing* the *intestine motion*, and *restraining* the *flight* of the *fixed air*.

If we attend to all the methods that are used to prevent bodies from putrefaction and decay, we shall find that they mostly tend to this single point: Timber is covered over with paint, or some such unctuous and tenacious matter; fruit *, and other green vegetables, are preserved the year round, by slightly scalding them (which thickens their external coats, naturally formed to prevent the escape of their air) and then drying them well, and putting them into bottles closely stopped; the larger kind of seeds, such as chesnuts and acorns, have been preserved by Mr. *John Ellis*, sound, and in a condition to grow, for nine months, by rendering their natural, tough, and compact coverings, still more firm, from a thick coat of bees wax and suet; flesh meat of all sorts is preserved

* Such as apples and gooseberries for baking.

on the same principle, and may be kept for many months, without much seasoning, provided it be well roasted or baked, and then covered over with lard, butter, or suet; and eggs, it is well known, will remain fresh for a long time, if their shells be coated over with melted suet, or the like tenacious substance.

ANIMAL fluids, likewise, if the air is not suffered to escape from them, remain for a great while, without growing putrid; surgeons often meet with large collections of extravasated blood, or serum, which, after lying for years, in their own firm and compact cysts, do not betray any thing putrid on their being first let out; but in a very short time after the opening is made, and there is a way for the air to fly off, the discharge grows intolerably fetid; and we also find, where wounds are made in fleshy parts by simple incision, and are so circumstanced as to lay under no necessity for frequent dressing, that, when carefully kept covered, and the escape of the air prevented, they heal in a very short time, without any sign of suppuration, which is a certain degree of putrefaction.

THE principle upon which *astringents* become *antiseptics* is easily comprehended.

THE action of *astringents* consists in their corrugating, or crisping up the animal fibres, whence the solid particles of these fibres are brought to a nearer approach, and the power of their cohesion considerably increased; consequently, the substance of the body, so acted upon, must become more firm, and compact, and this of course must hinder the *intestine motion*, without which there can be no putrefaction.

ALL bodies possessed of this *astringent power*, with regard to the *fibres*, and which, at the same time, have a strong *affinity* with *water*, must be *antiseptics* on a double account; accordingly, we see whence it arises, that *ardent spirits*, and the strong *mineral acids*, especially the *vitriolic*, resist putrefaction so very powerfully: For these not only absorb the *water* from the putrescent substance, but likewise crisp up its *fibres*, and thereby render it so hard and durable, that no change of combination will take place for many years.

So far in relation to the virtue of things *opposing* putrefaction; let us now proceed to consider those which have the power of
restoring

restoring sweetness to substances actually putrid.

EXPERIMENT 6.

HAVING put a number of small pieces of mutton into a phial with water, and placed it in a moderate degree of heat, in order to make them putrefy the sooner, I found them, after standing four days, sufficiently soft and putrid; I then put *five* of these bits of putrid mutton into as many cups, and poured, on the first, *spirit of vitriol*; on the 2d, *spirit of sea-salt*; on the 3d, *vinegar*; and on the 4th, *fresh lemon-juice*; the 5th cup contained only water, and was left as a standard, by which the others were to be compared*.

To have a synoptical view of the changes from day to day, I formed the annexed table, No. 5, and at the expiration of twenty-four hours, found the several appearances exactly as set down in the first column thereof; after forty-eight hours, the appearances were agreeable to the second

* The mineral acids in this experiment were diluted so as to reduce them, as nearly as could be judged, to the strength of the vinegar that was used.

Table V. ACIDS tried as Correctors of Putrefaction.

ACIDS of	24 Hours.	48 Hours.	3 Days.	4 Days.
Vitriol.	The bit of putrid flesh was found hard, shrivelled up, and almost sweet.	Entirely sweet; very much shrivelled and hardened.	As on the day before.	As on the day before.
Sea-salt.	Not so much hardened as in the Sp. Vitrioli, nor so much sweetened.	More sweet than on the preceding day, but not entirely sweet.	No change since yesterday.	Putrid smell returned.
Vinegar.	Softened ; greatly swelled, and entirely sweet.	No change since yesterday.	No change.	Grown livid, but still soft and sweet.
Lemon-juice.	Softened ; greatly swelled, and entirely sweet.	No change since yesterday.	No change.	Grown perfectly white, but quite sweet.

column of the table; at the end of three days, things stood as in the third; and after four days, the several bits of the mutton were found in the condition expressed in the fourth column.

BEING thus satisfied of the power of *acids* to *correct* putrefaction, I threw out all the pieces of the mutton but the 5th, which had served for a standard; reserving it for another experiment.

THUS it appears, that the *vitriolic acid* has a more powerful antiseptic virtue than the *marine*; and that both of them shew an *astringent* quality, by their hardening animal fibres, though in a different degree; and the effect of the *vegetable acids*, in so remarkably softening and relaxing the solid fibres, gives room to expect great things from their power as resolvers, when outwardly applied.

SINCE *acids* both *resist* and *correct* putrefaction, it was very reasonable to expect that all putrid diseases should yield to them, when given in the way of medicine; but *experience*, the only thing on which the *practice* of *physic* must always rest, abundantly shews that their power in this respect is pretty much limited; and that
where

where the putrid matter to be corrected lies beyond the first passages, *acids* are found quite insufficient to conquer it.

EXPERIMENT 7.

BUT the *alkaline* salts even exceed the *acids*, in regard to the power of correcting putrefaction; for two small pieces of putrid beef, after lying a night in the *volatile alkali**, diluted with water, in the proportion of four of the latter to one of the former, were found perfectly free from the putrid stench; but they were so fully charged with the liquors in which they had lain, that not even boiling could destroy the peculiar smell of the *volatile alkali*.

EXPERIMENT 8.

THE *fixed alkali* likewise sweetens very powerfully: A little bit of putrid beef, from lying twenty-four hours in *lixivium tartari*, diluted with an equal quantity of water, became hard and firm, and was

* Both the mild and the caustic alkalies were tried; viz. Spiritus cornu cervi per se, & Spiritus salis communiaci cum calce viva.

found to have no smell, but that which is peculiar to the *lixivium*.

EXPERIMENT 9.

BUT the *neutral mixture* does not give sweetness: *Spiritus mindereri*, if made in such manner as to be *perfectly neutral*, seems to have no power to correct putrefaction; if the *volatile alkali* is allowed to predominate, the mixture will sweeten in proportion, for, as hath been just now related, the *volatile alkali* is very powerful in driving off the putrid stench.

EXPERIMENT 10.

SPIRIT of *vitriol* and *lixivium tartari* being mixed to the point of saturation, and a bit of putrid beef being left in the liquor for twenty-four hours, was found not at all sweetened.

EXPERIMENT 11.

A STRONG decoction was prepared, from equal parts, *tormentill root*, *balauftines*, *pomegranate peel*, and *red roses*, and a bit of putrid beef was immersed in the liquor; the *fætor* seemed rather increased

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than

130 On the RESPECTIVE
than diminished, by lying twenty-four
hours in this decoction.

EXPERIMENT 12.

THE same thing happened with *lime-water*, which, notwithstanding it *resists* putrefaction so strongly, appears to have no power to *correct* it.

EXPERIMENT 13.

NEITHER have *ardent spirits* the least power to destroy the putrid stench, any further than as it is, in some degree, obscured by their own peculiar flavour.

EXPERIMENT 14.

STRONG decoctions of the *bark*, and of *valerian*, together with strong infusion of *chamomile flowers*, were also tried as sweeteners. After suffering three small pieces of putrid flesh to lie thirty-six hours in these liquors, I could scarcely take upon me to say they were sweetened; the putrid stench indeed was rendered more tolerable, by the smell of the liquors, but did not seem to be much conquered.

FOR unless the decoctions be frequently renewed, as was done by Dr. *Pringle*, so
as

as by repeated affusions the viscid particles of the gum-resin may be applied in such quantity as will wholly entangle and fix the volatile particles of the *putrid alkali*, the effect is but small; excepting the putrid body is allowed to remain long enough in the decoction or infusion for a *fermentation* to begin, which will indeed effectually change the state of the mixture, and produce such a new combination as will maintain its sweetness for a considerable length of time.

THIS power of *fermenting mixtures* to restore sweetness was discovered by Dr. Pringle; but as I have made several experiments in relation thereto, I shall here lay them before the reader.

EXPERIMENT. 15.

WHILE the 6th experiment, with regard to the power of acids in correcting putrefaction, was going on, I one evening took a bit of the mutton out of the *store phial*, which was grown, by that time, exceedingly soft and putrid, and having fastened it to a thread, immersed it, at eight o'clock, in a vat of *melasses wash*, at the distillers, then in a degree of fermentation,

tation, rather upon the decline. Next day at noon, I took it out, and having washed it in water, in order to free it from the smell of the liquor in which it had been lying, found it perfectly sweet and firm.

As this piece had been rendered so entirely sweet and firm, and, to all appearance, sound, for it looked like a bit of meat that had been slightly fried, I conjectured that it might not be necessary for it to lye so long as sixteen hours; I therefore obtained a gallon of the wash from my friend the distiller, that I might examine the progress at home, and at my leisure.

EXPERIMENT 16.

I plunged into this gallon of fermenting liquor the very identical piece of mutton that had served as a standard in the 6th experiment, on the acids; and which, from lying in an open cup for several days, was grown so soft that I was obliged to tie it round with a piece of thread, (for, when the thread was passed through it, the flesh was so tender that it would not hold) and so extremely putrid that the stench was intolerable.

IN *one* hour the putrid smell was much abated, and at the end of *five* entirely gone, the meat being now firm, and perfectly sweet; it was hung up in the open air, where it soon became dry, and remained sweet ever after.

EXPERIMENT 17.

IN order to see whether this change depended on the liquor, or on the vapour, I suspended a thin bit of putrid mutton, from the *store phial*, in the mouth of the vessel wherein the *wash* was fermenting, but so as not to touch the liquor, and left it there during the night; in the morning it was found plumped up, sweet, and firm.

THIS experiment I frequently repeated, and always with success; but whoever chuses to try it, must take care that the pieces of putrid meat be cut thin, so as the vapour may have power to pervade them, otherwise the sweetness will not be completely restored; whereas, when the experiment is made with the liquor, and the pieces of putrid flesh are suffered to lie soaking in it, they may then be cut of any size that the party pleases; for if time be

given, the subtile gas will penetrate, and produce its effect.

EXPERIMENT 18.

EVEN *acids* will sweeten pretty large pieces; two bits of putrid beef, of an ounce weight, were left severally in *distilled vinegar*, and in *melasses wash*, just as it had done working.

THE first was found very much, though not entirely, sweetened, after lying twenty-four hours; but the second was rendered perfectly sweet. In order to see if they were thoroughly penetrated, and sweetened to the heart, I boiled both the pieces, and was surprized to see the one which had lain in the *acid* go all to pieces in the boiling, which I thought the more odd, as it had been rendered hard and firm; an effect wherein the *distilled vinegar* differs widely from that which is *not* distilled. This dissolution I ascribed to the peculiar *dissolvent quality* of the vinegar, and did not believe, until I tried it, that a *mineral acid* would produce the same effect.

EXPE-

EXPERIMENT 19.

BUT an ounce of putrid beef, after lying twenty-four hours in *dilute spirit of vitriol*, and coming out perfectly hard, sweet, and contracted, upon being boiled, fell all to pieces, exactly as did the one which had lain in the distilled vinegar; and when rubbed between the fingers, it melted away like so much wet paste. To be certain that nothing of this was owing to too much boiling, I put a little bit of beef, of a drachm weight, that had been sweetened by the *volatile alcali*, into the vessel along with it, and suffered it to remain the whole time of the boiling; but it came out white and firm, and, as hath been mentioned already, strong of the *volatile alcali*.

FOR the *alcalies* cannot be said, with propriety, to restore sweetness; they only drive off a *weaker alcali*: As the *fixed alcali* can dispossess the *volatile*, so both of them have the power to drive off the *simple putrid alcali*; and thus the putrid substance becomes the *basis* of a *stronger*, instead of a *weaker*, alcali*.

* See the 27th, 29th, 31st, and 32d experiments of the preceding essay.

THE manner in which *acids* sweeten putrid flesh seems also pretty plain; for their action appears to consist in *saturating* and *fixing* the *putrid alkali*, and by thus destroying its *volatility*, they hinder the putrid *fætor* from flying off, and striking the organs of smell; but at the same time that *acids* do this, they *dissolve* the *elementary earth*, and thus destroy the texture of that substance whose soundness they were supposed to restore. Whereas, the peculiar excellence of the fermenting liquors is, to restore sweetness to the fluids, and firmness to the solids,

EXPERIMENT 20.

Two pieces of linnen rag were dipt in the putrid liquor of the *store phial*; one was suspended over the *wash* in fermentation, and the other was hung up in the open air. In two hours the one exposed to the *vapour* became almost sweet, the other remaining as offensive as at first; and in six hours, the first piece of rag had no smell but that of the vapour; while the other, though now grown dry, still strongly retained the putrid stench,

As

As sugar is an antiseptic, in consequence of its saline nature, I did not know but somewhat of the virtue of the *melasses wash* might depend on this circumstance.

In order to determine this, I immersed one small bit of putrid flesh in a mixture of bread and mutton, with lemon-juice, and suspended another in the neck of a phial containing a fermenting mixture, with spinnage; and found, after eight hours, that both of them had lost the putrid stench, and had now no other smell than that of the mixtures; which, as hath been elsewhere observed, was sweetish, and not unlike fenugreek seed. The like experiment was tried with another fermenting mixture, as the reader will find by turning back to the 47th page.

Dr. *Pringle* seems to think, that the putrid smell in these mixtures is destroyed by the *acid* which is produced in the course of the fermentation. Relying on his authority, I was for some time of the same opinion, and looked on the *subtile gas* as somewhat of the nature of a *volatile acid*; for I had *then* the *ideas* of *acid* and *antiseptic* strongly connected together in my mind;

mind: but, upon enquiry, this notion was found to be void of foundation.

EXPERIMENT 21.

FOR one piece of linnen rag dipped in *lixivium tartari*, and another tinged *blue* by the scrapings of *rhadishes*, were exposed for eight and forty hours to the vapour arising from a large vat full of melasses wash, in high fermentation; yet the first was not at all saturated, nor the last in any, even the slightest degree, changed red.

AND in all the fermenting mixtures that I tried, none of them became sour, excepting one (No. 6, table 1), for several days after the first stage of the fermentation had ceased *.

EXPE-

* In order to see how long these kind of mixtures would preserve their sweetness, I reserved three of the 14th experiment of the second essay; to wit, those with the barley, the rice, and the oats.

Into the phial with the barley I put about half an inch of a thread which had been dipped in a putrid animal fluid; into the one with the rice I poured a teaspoonful of vinegar; the third, with the oats, was left without any addition.

All the three mixtures were now at rest, having run through their first stage, and being every one perfectly sweet,

EXPERIMENT 22.

Two drachms of the *cortex* in powder, and half an ounce of *saliva*, were added to a mixture of *ox-gall* and *water*, which was grown *putrid*, for it had been used

sweet, they were left in the common temperature of the air; the phials not closely stoppt. (This was in the month of *July*.)

For three weeks, no alteration was perceivable in any of them; but at the end of that time, the mixture into which the putrid ferment had been put began the intestine motion, which continued, in a gentle degree, for seven or eight days before the mixture became fully putrid.

The phial into which the vinegar had been thrown, began, at the three weeks end, to shew some small signs of intestine motion; a thick, white scum formed on the surface, and it did not grow putrid until it had stood, in all, six weeks.

The third mixture, to which nothing had been added, remained quite at rest, without shewing any signs of motion for two months; then it was found to have grown sour, and had contracted acidity sufficient to curdle milk, and to raise an ebullition when some salt of hartshorn was thrown into the phial.

I now corked the phial, and set it aside for three months; and then, having distilled the mixture by a very gentle heat, I obtained a *volatile alkaline spirit*, of a peculiar smell, not unlike that obtained from the putrid blood formerly mentioned.

as a standard to two mixtures of gall and *testacea*.

UPON the first mixture, the *fætor* increased greatly, and the bark seemed to act on the putrid bile in a manner not unlike the action of *lime*, or *fixed alkali*, when mixed with *crude sal ammoniac*, in order to drive off the *volatile alkali*.

THE mixture was now laid by for twenty-four hours, at the expiration of which I found the putrid smell much abated, and a fermentation beginning; I now suspended a little bit of putrid flesh in the neck of the phial, and placed it in a moderate degree of heat. When twenty-four hours more were elapsed, I again examined the mixture, which was still in brisk motion, and found that it had entirely lost the *fætor*, having now acquired a new and peculiar smell, which was not only sweet, but agreeable, and different from the original smell, either of fresh bile, or of the *cortex*.

THE bit of putrid flesh was found sweetened; having removed it, I fixed the bended glass tube as described formerly, and, by means thereof, joined a small phial, containing a drachm of *non-effervescent*,
volatile

volatile alkaline spirit, to the phial which held the fermenting mixture: They were left in conjunction for twenty-four hours, and when separated, some *spirit of vitriol* being dropped into the small phial, raised a smart ebullition.

It has been shewn in former experiments, how readily the *bark* runs into fermentation out of the body, and it was then hinted, that there is great reason to expect that it will be still more prone to ferment in the body, when opened by the digestive fluids; and the present experiment shews plainly, that when opened by fermentation, the *cortex*, like the *melasses*, and other things that were tried, gives out some subtile matter, which hath the power of restoring sweetness to putrid animal substances: Is it not agreeable, then, to reason as well as experiment, to account for its *antiseptic* virtue upon this principle?

If we attend to the nature of the diseases wherein the bark is found most useful; and, on the other hand, remark those cases wherein it either does harm, or proves of no effect, we shall find some ground for establishing this *hypothesis*.

barbados

FIRST,

FIRST, the *cortex* is of the highest service in *gangrenes*, where the vessels are relaxed, and the blood dissolved; 2, in wounds and ulcers, where the solids and fluids are in the same weak and dissolved state; 3, in the low state of malignant fevers, and small-pox, where the humours are evidently putrid; 4, in intermittent fevers, where almost every symptom betrays evident marks of a putrefactive acrimony.

IN these last it seems to be the most plausible opinion, that the cause is seated originally in the flexure of the duodenum*; here the *cortex* comes into immediate contact with the putrefactive *colluvies*, and presently† running into fermentation, soon throws off a quantity of the subtile vapour, sufficient to saturate the acrimonious matter; which being thus

* See *Hoffman*, in the chapter *de consensu partium nervosarum generatim & sigillatim cum ventriculo*. *Pringle*, p. 330. And *Cleghorn's Diseases of Minorca*, p. 161 & 183.

† The putrid matter will encrease the tendency to putrefaction. Thus we see how well it is adapted to work out its own cure, provided it be supplied with proper materials.

rendered

rendered mild and sweet, the febrile commotion, which would have ensued had this irritating cause not been removed or corrected, is now prevented.

IN this case, we have supposed the general mass of fluids to be untainted; but, even in cases where the putrefactive acrimony has made further advances, and has actually taken place in the constitution, if the medicine be continued, and given in large quantities, its salutary effects will presently appear, and will shew that the *antiseptic vapour* can reach the blood, and there restore its consistence, and correct its sharpness.

BUT this valuable drug has another great advantage. Beside its readiness to ferment, and being able to yield a large proportion of the *antiseptic vapour*, it hath also a remarkable power of bracing up and strengthening the vascular system; thus enabling the powers of the body to concoct the morbid matter, and expel it by the proper emunctories: For it is observable, that, after a liberal use of it, profuse evacuations of urine and sweat often ensue, and sometimes beneficial discharges by stool; then, when the offending mat-

ter

ter is so thrown off or corrected, the astringent quality of the bark braceth up and strengthens the solid fibres, which had been relaxed and weakened by the putrefactive acrimony.

BUT in diseases where there is an inflammatory tendency, where the vessels are full, the fibres tense and rigid, and the blood thick and sizy, then is the bark hurtful and dangerous; because, it throws much air, and no water, into the blood, and consequently must highly increase the morbid disposition of the fluids, while, at the same time, its astringent virtue must add to the *tension* of the *living solids*.

FOR this *subtile antiseptic vapour* appears to consist chiefly, if not altogether, of the *fixed air* of the fermenting substances; since I have found, by experiment, that as the *fixed air* thrown off by *effervescence* agrees with the *gas sylvestre*, in *suffocating animals*, so does it agree with the same gas, in the property of *restoring sweetness*.

EXPERIMENT 23.

A SMALL piece of putrid beef, taken immediately from the liquor in which it lay, was put into a cup with some *lixivium tartari*,

tartari, and on it was poured by degrees, a sufficient quantity of *spirit of vitriol*.

THE moment the saturation was complete, the bit of beef was taken out, and found to have almost entirely lost the putrid *fætor*; what smell it now had, was rather to be termed musty than putrid; on washing it in clean water, this musty smell went off, and a very little of the putrid was again to be perceived.

EXPERIMENT 24.

ANOTHER bit of the same putrid beef was put into a cup, with some *salt of hartshorn*, and on them vinegar was poured, to the point of saturation: Immediately on the cessation of the ebullition, the piece of flesh was taken out, and found to have entirely lost the *fætor*, having now no smell but that of the neutral mixture, which is not unlike the smell of burnt horn; but upon washing the beef, this smell went off in great measure, and not the least of the putrid stench was to be perceived. This bit of beef was much softer than the one in the foregoing experiment, where the effervescence was not near so violent, and did not last so long, as in this present mixture;

ture; and hence I concluded, that this last piece of the putrid flesh was so much more sweetened, because of its having an opportunity to *absorb* a much greater quantity of *air* than the other one had.

BOTH these pieces were boiled, and both came out perfectly firm; the last piece, upon being cut into, was found sweet to the very heart; but the other was found not to have been so thoroughly pervaded, as it discovered a little of the putrid smell on being divided.

E X P E R I M E N T 25.

A BIT of putrid flesh, of about a drachm, was put into the phial C, as in figure 11, which previously had a drachm or two of *sal cornu cervi* thrown into it, the glass tube was fixed closely into the neck of the phial, and the other extremity of the tube inserted into a small phial, with half a drachm of the putrid liquor that lay about the rotten flesh; vinegar was now poured through the funnel, to raise an ebullition. When the salt was all dissolved, and the effervescence at an end, the phials were separated; the bit of beef was now found sweet, and the putrid liquor, which before

fore shewed no signs of ebullition upon dropping an acid into it, *now* effervesced plainly, on the addition of *spirit of vitriol*; and it had besides lost much of the putrid *fætor*.

AND thus we see, that fermenting and effervescent mixtures are the most powerful of all known *antiseptics*.

SOME share of this power remains in liquors after they have run through their first stage of fermentation, which is different in different liquors; as may be seen in the annexed table (No. 6), and seems to depend on the quantity of the subtile vapour which is left in the liquor, since those that are most sparkling and brisk, are found to possess the greatest share of antiseptic power*.

THE *fixed air*, when transferred from a sound body into one that is putrid, appears

* "When, by fermentation, the constituent parts of a vegetable are separated, part of the air flies off into an elastic state; part unites with the salt, oil, and earth, which constitute the tartar; the remainder, which continues in the fermented liquor, is there, some of it in a fixed, and some of it in an elastic state." *Hales*, vol. i. p. 300.

Table VI. COMMON FERMENTED LIQUORS tried as Sweeteners of Putrid Flesh.

Claret.	Lisbon White Wine.	English Cyder, (bottled.)	Common Dublin Ale.	Melasses Wash, (newly fermented.)	Sugar and Water, (not fermented.)
At the end of 30 hours, the bit of putrid meat was found perfectly sweet and firm.	At the end of 12 hours, the bit of meat was found perfectly sweet.	At the end of 8 hours, the bit of meat was found quite sweet.	After 24 hours, not at all sweetened. <i>N. B.</i> This kind of ale is but of the weaker sort, and generally not very brisk.	In 12 hours, the bit of putrid meat became perfectly sweet.	After 24 hours, not at all sweetened.

to restore to that body the *principle* that had been destroyed or lost *.

BUT here it may be demanded, what can these experiments prove with regard to the restoration of putrid fluids, in a living body; is it possible to saturate these humours with such a quantity of air as will be sufficient to *correct* their *sharpness*, *restore* their *consistence*, and *bring back* their *sweetness*?

To this it may with safety be replied, that it is not only possible, but that it is, perhaps, the only way by which this change can be produced.

FOR we have seen that there is a deception, in regard to both *acids* and *alkalies*, when we suppose them to restore sweetness to a putrid animal substance; that the *first*, so far from giving soundness to such kind of substances, do in reality destroy their *texture*; and that the *second* only change the nature, but do not restore the original sweetness.

* The manner of acting of air, when transferred into a body whose texture is broken and dissolved, will be better comprehended from some experiments hereafter to be mentioned in the 5th Essay; the thing being, in some degree, rendered visible.

BUT *acids*, we have likewise seen, are *neutralized**, during the alimentary fermentation, and therefore they cannot act as acids, by saturating any thing of the *alkalious* kind that they meet with in their course of circulation. The power of *acids* therefore, is confined; and we are not to expect, that they are to pervade the minute branches of the vascular system; indeed, it is evident, that they *ought not* to be allowed to pass into the *blood* in their *acid form*, since it is plain, that, from their dissolvent nature, the body must be destroyed, and its most solid parts melted down to a jelly, if *naked acids* were to be received into the general mass of fluids †; Their action, therefore, cannot extend beyond the limits of the alimentary canal, where they may come into contact with, and correct the sharpness of a putrid colluvies. In these cases they may, and actually do, exert very notable powers, as is

* See the 3d and 5th experiments of the 2d Essay.

† In those deplorable cases that now and then happen, where all the bones become soft, a manifest acidity hath been discovered in the fluids; a thing never observed in other morbid cases. See *Haller. Element. Physiolog.* tom. ii. p 94.

often experienced, by their preventing sickness and nausea, and restraining vomitings; and by neutralizing, as it may be termed, the putrefactive matter, thus prevent it from carrying into the blood its peculiar destructive quality.

It is a point not yet thoroughly settled, whether *alcalies* do in reality promote putrefaction in *living bodies*; there can be no doubt of their power to resist and correct putrefaction, in *dead bodies*; but whether, upon the presumption of this virtue, they can be given with propriety, as antiseptics, is not so clear.

A VERY eminent and successful practitioner is of opinion, " That the exhibition
 " of volatile alcalious salts to the sick, in
 " putrid diseases, is adding fuel to the fire;
 " for they certainly dissolve or break the
 " globules of the blood, and thence more
 " speedily bring on the general putrefac-
 " tion." And he relates a singular case, where an uncommon quantity of *salt* of *hartshorn* being taken by a young gentleman, and the use of it continued, " An
 " hectic fever ensued, as also vast hæmorrhages from the intestines, nose, and
 " gums; every one of the teeth dropped

“ out, and the patient could eat nothing
 “ solid ; he wasted vastly in his flesh, and
 “ his muscles became as soft and flabby as
 “ those of a new-born infant ; and broke
 “ out all over his body in pustules, which
 “ itched most intolerably, so that he
 “ scratched himself continually, and tore
 “ his skin with his nails in a very shock-
 “ ing manner ; his urine was always exces-
 “ sively high-coloured, and very foetid*.”

ASTRINGENTS, as hath been shewn, prevent putrefaction very powerfully, but we find that they have not the least degree of power to correct it.

BUT putrefactive acrimony first takes place in the *fluids*, and it is on account of *their* indisposition, and the destructive and

* *Huxham on the Sore Throat*, p. 67 & 68. The acrimony in this case, however, appears to have been what *Gaubius* terms, “ *Acre alcalescens volatile purum* ;” which, though a component part, is not to be confounded, or looked on as the same, with the real and genuine putrid acrimony.

Gaubii Init. Patholog. sect. 310 & 312. Putrid acrimony seems to consist in an over-proportion and irregular combination of the saline and phlogistick or oily particles of the blood ; these particles being left at liberty to run into this destructive combination from the want of their *bond of union*, the *fixed air*.

irregular

irregular combination of *their* particles, that the texture of the *solid fibres* is weakened, and their cohesion impaired; therefore, bracing up and strenghtening the system of solids, while the mass of fluids continues in the morbid state, can avail nothing; it is beginning the cure where it ought to be concluded.

ASTRINGENTS, therefore, as *antiseptics*, can only be of importance in those cases, where, from extreme relaxation and resolution of the solids, the dissolved fluids are suffered to transude, and either form spots of different hues, or run off by actual hæmorrhage; here indeed, the *acid* of *vitriol*, as an *astringent*, not as an *acid* (for *vinegar* would do nothing in this case) is found of great use, in *gaining time*; either, till the powers of the animal œconomy correct the morbid disposition of the fluids, or that the same thing is brought about by the virtue of some efficacious *antiseptics*, such as the *cortex*, which is the thing usually joined with the *spirit* of *vitriol*, and that with the greatest propriety, on account of its own astringent quality, as well as extreme readiness to run into fermentation;

tion; which is the circumstance that constitutes a true and genuine antiseptic.

THE physician who gives astringents in these cases, and with these views, acts not unlike a surgeon who secures and ties the blood-vessels that are divided in the beginning of an operation, in order to allow himself sufficient time to finish it with safety and regularity.

INDEED, the credit that *acids* have gained as *antiseptics*, hath rested much on the success that has attended their exhibition in the circumstances above-mentioned; but that they act in these cases as *mere astringents*, may be found from a close attention to the progress of the cure.

LET any one read the very remarkable case in Dr. *Huxham's* Treatise on Fevers, (p. 62) and it will plainly appear that the *acid* of the *vitriol* braced up the fibres, checked the transudation of the dissolved blood, and thus obtained a truce until the repeated doses of the *cortex*. “ The *rice*,
“ the *panado*, the *sago*, the *hartshorn-jelly*,
“ well acidulated, and the *toast* out of *claret* and *red port wine*,” generated enough of the *antiseptic vapour* to saturate and
correct,

correct, in some degree, the putrefactive acrimony, whereby the patient was enabled to get upon his legs, when exercise, and a proper diet, restored him to his perfect health*.

AND to shew this still further, in a case no less deplorable, I shall give the following, communicated by Dr. *Archer*, physician to *Stevens's Hospital* in *Dublin*.

THOMAS BROWN, a robust countryman, of about twenty-four years of age, was admitted, the first of February, 1762, a surgical patient into Dr. *Stevens's Hospital*, for an *Herpes exedens*, which extended from the nape of the neck to the inferior part of both *scapulæ*. After having been purged, on the 5th he was ordered to take ten grains of the blue pill every day, which he did until the 25th; so that in this time he had taken near two hundred grains of *mercury*, without any appearance of salivation†.

ON

* There is a case in *Sydenham* equally strong in regard to this point; it was communicated by Dr. *Goodall*, and is to be found in the Letter to Dr. *Cole*, concerning the small-pox and hysteric diseases.

† This blue pill used in *Stevens's hospital* consists of
6 nothing

ON the 26th, he complained of sickness in his stomach, entire loss of appetite, and great weariness; the ulcer had not mended; he was therefore confined to his bed, and ordered to drink plentifully of warm diluting liquors. The 27th, there appeared numerous *petechiæ* on his whole body. The 28th, the number of these increased, and appeared livid. The 1st of March, he had a hæmorrhage from the nose, which was attempted to be stopt by different styptics; but these causing him to sneeze, rather increased the bleeding: The same evening he was ordered a vomit, which he took, and another next morning; by these the bleeding likewise encreased.

THE apothecary of the house (it not being the physicians' visiting-day) then ordered him three spoonfuls of the following mixture, to be taken every two hours.

R. Aq. Mentb. vul. Sim. Tinct. Rosar. cum triplici quant. Elix. Vitriol. Acid. aa uncias tres Tinct. Cort. Peruv. uncias duas.

nothing but crude mercury, and as much Venice turpentine as is sufficient to extinguish the quicksilver.

Tinct.

Tinf. Martis in Sp. Salis, Sescunciam
M.

THIS, he said, restrained the hæmorrhage; but, on the 3d, blood came away abundantly in his urine.

HE continued the above mixture until the 4th, when I was desired to see him: I found him greatly exhausted, his pulse quick and weak, frequently spitting black coagulated blood, his urine the colour of blood, his body thickly covered over with *petechiæ*, red and livid, which here and there ran into *vibices*, as if he had been severely scourged.

I ORDERED him to take a drachm of the *cortex* every hour, washing it down with four ounces of the *infusum amarum* of the London dispensatory, with thirty drops of the *acid elixir* of *vitriol* in each dose.

AFTER taking a few doses, he imagined himself better; and therefore, of his own accord, took it every half hour. The 7th, the blood disappeared from his urine, and greatly abated from his mouth and nose; the livid *petechiæ* changed to red, and the *vibices* into distinct *petechiæ*. The 11th, all the hæmorrhages ceased, and the *petechiæ*

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chia had almost disappeared. On the 15th, they were entirely gone. He continued his medicine, however, until the 27th; on which day, his *herpes* was completely skinned over. During this time, *viz.* from the 3d to the 27th, he took *fifteen ounces* and *six drachms* of the *cortex*.

THE antiseptic virtue of the other gummy resinous vegetables, if we may judge of them all by this capital one, the *cortex*, appears also to depend on their fermenting in the body; and as these substances contain a large proportion of the *fixed air*, they must part with much of it in the course of their fermentation: For now that we have taken a view of the several kinds of *antiseptics*, and have seen how much the action of *salts*, and of *astringents*, is limited, we find that the only dependance must be on those things that throw a *great quantity* of *air* into the blood, if we expect to work a complete change on the whole mass.

IF we attend also to the things that *prevent* putrefaction in *living* bodies, we shall still find that the dependence is on the quantity of *air*.

THERE

THERE can be doubt but that it is the vegetable part of our food which yields by far the greatest share of the air, that enters the composition of the animal fluids; and *vegetable food* most certainly prevents the *putrefactive diathesis*. Dr. Pringle ascribes it, and with great justice, to the frequent use of fresh vegetables and sugar, which now make up so great part of the diet of the *European nations*, that we at this day so seldom hear of the dreadful putrid diseases which formerly swept off such multitudes, every thirty or forty years, and generally went under the name of plagues*.

THE effects of being deprived the use of fresh vegetables, are strongly manifested in the fatal scurvies, fevers, and dysenteries, to which seamen, and people pent up in garrisons, are often subject: In short, this matter is so well known, and every body is so sensible of it, that it would be a trespass on the reader to insist on every particular instance; I shall therefore only request, that he may observe, in general, the kind of diet which is most wholesome

* See also *Hoffman*, in the chapter *de Venenis in Aere Contentis*, &c. sect. 26.

in hot climates; that it must, in order to preserve health, consist very much of vegetables, and of those kinds which produce the greatest quantities of air, in order to afford a sufficient supply of *antiseptic vapour*, to make up for the extraordinary waste of air which is carried off from the fluids by profuse perspirations; and that those people must inevitably fall into putrid diseases, who eat much animal food, which produceth but little air, who drink much spirituous liquors, that contain no air themselves scarcely, and prevent the ready extrication thereof from the aliment, during the digestive process, and who incautiously expose themselves to a moist atmosphere, which hinders any thing but the *aerial* part of the perspirable matter to be carried off.

ON the other hand, in the cold climates, we may more safely indulge in animal food, and in spirituous and fermented liquors, because, in these, the expence of air by perspiration is so much less.

TAKING the matter in this light, we may possibly assign reasons,

I. Why

1. Why carnivorous animals perspire but little? A fox, though hunted almost to death, never sweats.

2. Why animals, whose food consists entirely of vegetables, perspire so much? Horses and cows, for example; how often are these creatures seen involved in a cloud of their own vapours, and covered over with froth?

3. Why animals, whose natural food is vegetables, can be kept alive and in health, in very cold climates, by feeding upon animal substances? Cows in *Norway* and in *Iceland* are fed, in winter, upon fish-bones.

THIS general and well-known *antiseptic* quality in *vegetable food*, is commonly accounted for by saying, that it produceth *acescent chyle*; but *alcalescent* or *putrescent* vegetables are equally powerful, in this respect, with the *acescent*; therefore, the *antiseptic* quality must depend upon something that is general, and common to all vegetables*.

INSTEAD

* By far the greatest share of the vegetables used in common diet, if we except the *fruits* and *farinacea*, are *alcalescent* or *putrescent*; witness all the different kinds of *brassica*, the *nasturtia*, *onions*, *leeks*, *garlick*, *horse-radish*,
M

INSTEAD of calling *chyle* produced from a vegetable diet *acescent*, we shall speak with more propriety, as well as approach much nearer the truth, by terming it a fluid composed of animal and vegetable juices, in the *first* or *sweet* stage of *fermentation*, impregnated and fully charged with a subtile, active, and penetrating spirit, which is highly antiseptic.

THIS notion of *acescent chyle* has such an influence on the practice of physic, that it is apt to present *acids alone* to the consideration of the physician, in *putrid cases*, and too often diverts from those things that are the true opposers and genuine cor-

disb, *mustard*, *raddishes*, *spinnage*, *endive*, *purslain*, *lettuces*; not one of these things can be called *acescent*, and yet they preserve the humours from putrefaction, or correct it when present, as effectually as sorrel or lemon-juice. We sometimes find in systematic writers, laid down among the general causes of the *putrefactive diathesis*, the too liberal use of such sort of vegetables; but I apprehend there are few, if any, instances of a putrid disease arising from the use of any sound, fermentable vegetable.

Indeed, where people have been obliged to feed on such vegetables as were unsound, and incapable of the alimentary fermentation, there it will readily be granted, that the very worst of putrid diseases have ensued.

rectors of putrefaction, namely, fresh vegetables, and other fermentable matters, which readily yield a large proportion of *air*, since *this*, upon comparing all the circumstances, will be found the *grand antiseptic* *, which not only has the power to *preserve* animal fluids from corruption, but can also *restore* them, after having undergone some degree of putrefaction.

BUT what proves, almost to a demonstration, the antiseptic power of *air*, is the cure of the *sea-scurvy*. This disease, wherein the whole mass of fluids is dissolved and corrupted, cannot be cured by any other means than by throwing in a large quantity of *new air*; and this must be done in the way of diet; it must be furnished from things that can be taken into the body by pounds, not in ounces or drachms; and therefore that vegetable is found to be the most powerful antiscorbutic of which the patient can take the largest

* I doubt not but the saying that air is the *grand antiseptic* will sound oddly at first; but I desire that it may always be remembered, that *air* is the *bond of union*, the *vinculam elementorum primum*; and that *putrefaction* consists in a *resolution* and *disunion* of the several constituent particles.

quantity, without occasioning sickness, or other disturbance.

IN the *scurvy*, the *digestive organs* luckily preserve their full powers, and therefore they can turn the fermentable substances, taken into the body, to their own proper advantage; and hence this disease scarce ever fails of being cured, provided the requisite materials be supplied.

BUT in *acute* diseases, arising from putrefaction, the case is far otherwise; every thing, here, is thrown into such confusion, that none of the animal processes can be carried on with regularity; and, on this account, the most powerful antiseptics, as well as every thing else, too often lose their power.

As the cure of the *scurvy*, then, seems to depend so very much on the *fermentative quality* in the remedies made use of, it is not impossible but other things, as well as *perfectly fresh vegetables*, may be found to answer this salutary purpose.

I IMAGINE that I have found out such a substance; I have had no opportunity, indeed, of putting it to the trial; but as I am firmly persuaded that it will be found of great service, not only in the *scurvy*,
but

but in other *putrid diseases*, at sea, where fresh vegetables are not to be had, I cannot refrain from throwing out a proposal for trying *new methods* of preventing, and possibly curing, those destructive diseases that take their rise from putrefaction, in situations where the unhappy patients are destitute of the most proper means of help; but as this requires a particular consideration, it shall be made the subject of another *Essay*.

HOWEVER, I will, in the mean time, recommend the trial of an experiment in that very destructive disease, the *putrid yellow fever* of the *West Indies*. And if these papers shall happen to fall into the hands of any practitioner in those climates, I request that it may be tried.

IT is, to give the patients repeated doses of the *alkaline salts*, in fresh *lime-juice*, or the like, and let it always be swallowed during the act of effervescence; and let the patient's drink be somewhat of the highly fermentable kind; I would even propose the juice of the *green sugar-cane*, diluted, and acidulated with some of the recent four juices *.

* A surgeon, who was some time at *Goree*, on the

POSSIBLY, by throwing in such a quantity of air as would be furnished from this kind of materials, the putrefactive acrimony, which at first seems to be lodged in the biliary system, might be corrected and saturated.

THE principle upon which the saline mixtures, when given during the ebullition, perform their action of sweetening and destroying the putrefactive acrimony, the reader can be no stranger to; or if he does not recollect it, he has only to turn back to the 23d, 24th, and 25th experiments of this present essay.

I FIND that Dr. *Lind* often prevents the fit of an ague, by giving these mixtures in the manner above-mentioned *. And *Riverius* used to check vomitings therewith in an instant; from what the discontinu-

coast of *Africa*, tells me, that the natives give in these fevers, with very good success, a drink prepared by macerating in water a fruit of the plumb kind, that grows there in great plenty.

* Which very much strengthens the *hypothesis* which I have laid down, in order to account for the operation of the cortex in the like cases; both the one and the other appearing to saturate, and sweeten the putrefactive *colluvies*, which is lodged in the *stomach* and flexure of the *duodenum*.

ance

ance of this practice hath arisen, I cannot undertake to say, unless that some passages in *Boerhaave* are so construed as to discourage it *; but I am informed, that it was in great repute at *Edinburgh* about thirty years ago, and I am persuaded that the exhibition of these effervescent mixtures is not only perfectly safe, but, in many cases, will be attended with great and immediate advantages.

* Particularly one in tom. i. p. 528. Though I do not find *Boerhaave* any where absolutely and expressly forbid this practice, yet I find that he used to do so in his lectures, if a manuscript that I have seen, of his *Colegium Publicum de Aere*, be accurately taken.

ance of this practice hath arisen, I cannot undertake to say, unless that some passages in Barrow are so confined as to mislead it; but I am informed, that it was in great repute at Edinburgh about thirty years ago, and I am persuaded that the exhibition of these effervescent mixtures is not only perfectly safe, but, in many cases, will be attended with great and immediate advantages.

* Particularly one in tome. p. 228. Though I do not find Barrow any where absolutely and expressly forbid this practice, yet I find that he used to do so in his lectures, in a manuscript that I have seen, of his Col. legium. I believe he has, he accurately taken.

It is not, however, to be understood, that I have taken any notice of this practice, as being either safe or unsafe, but only as being a practice which I have seen in a manuscript of his.

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ESSAY

ESSAY IV,

**ON THE
SCURVY;**

WITH A

PROPOSAL for trying NEW METHODS

TO

Prevent or Cure the same, at Sea,

ESSAYS IV.

ON THE

SICURY

----- *Si quid novisti rectius istis*
Candidus imperti WITH HORATIUS.

PROPOSAL for trying New Methods

TO

Prevent or Cure the same, at Sea.

ESSAY IV.

ON THE

SCURVY; with a PROPOSAL for
trying NEW METHODS to prevent
or cure the same, at Sea.

FOR some time, even before I engaged
in the course of experiments which
have been set forth in the three preceding
essays, I was firmly of opinion, that the
cure of the *sea scurvy* depended chiefly, if
not altogether, on the *fermentative quality* *
of

* Although the ingenious Dr. Lind ascribes somewhat to the fermentative quality, yet his theory rests chiefly on the *saponaceous, attenuating, and resolving virtue*, which, according to him, "is the chief, and most essentially requisite quality, in the antiscorbutic mixture." P. 304 of his Treatise.

But when we consider, that the disease consists in a *resolution* of the blood's fibres, we must plainly see that it *never* can be cured on the above-mentioned principle.

The theory, which makes the cure to depend on a
change

of the *fresh vegetables*; which are found, by experience, to be the only things that, with certainty, conquer this destructive disease. And in consequence of this persuasion, it occurred to me, that as these are vegetable substances, which, though not perfectly recent, are yet capable of fermentation, such in particular as *common malt*; that this, if taken in the way of medicine, would, in all probability, produce effects similar to those produced by green vegetables, and consequently cure the scurvy; and as *malt* can be preserved sound, for a considerable length of time, it might be carried to sea, and there kept, in order to make *wort* occasionally as it might be wanted; and thus prove a remedy, always in readiness, against that fatal disease.

SUCH was the scheme that I framed to myself; and the more I thought of it, the more I became convinced of the likelihood of its succeeding;

change produced in the diseased fluids, in consequence of the fermentation of the fresh vegetables in the stomach and bowels, was first taught (as I am informed) by Dr. Cullen, the celebrated professor of chemistry at *Edinburgh*, but was suggested to me by Dr. *Hutcheson*.

I SOON

I soon mentioned this affair to a set of medical friends, who having formed themselves into a little society, meet once a fortnight for their mutual improvement; and they thought the reasons on which my expectations were founded so plausible as to deserve the trouble of an experiment: So that all that was now wanting was an opportunity of putting it to the fair trial.

BUT as the *scurvy** is a disease very rarely to be met in this city (Dublin), and as I had not any acquaintance at the places where cases of this sort occur most frequently, I drew up my reasons for thinking that the *wort* would prove a remedy; in the form of a letter, and addressed it to my very worthy friend Mr. George Clegborn, lecturer of anatomy in the university of Dublin, with a desire that he would send it to some of the leading medical people in London, in order to engage them in an application to the gentlemen who have the care of the naval hospitals, that trial

* The genuine putrid scurvy, so fatal to seamen, and to people shut up in garrisons without supplies of fresh vegetables, is the disease every where meant throughout this Essay.

might be made of its effects at those places.

AMONG the gentlemen to whom Mr. *Cleghorn* transmitted copies of the letter, were Dr *Hunter*, and *Henry Tom*, Esq; one of the *commissioners* for taking care of *sick and wounded seamen*, whose zeal in the prosecution of this affair, and in endeavouring to get the proposal carried into execution, demands a publick acknowledgement; since it was through their application, that the *lords* of the *admiralty* did, in the month of May, 1762, give orders to have the *wort* tried in the naval hospitals at Portsmouth and Plymouth.

BUT as it was absolutely necessary, in order to determine the genuine effects of the remedy proposed, that the patients should, during the time of trial, be entirely debarred from any sort of recent vegetable, this restriction was deemed so severe, and looked so like retarding men's cures for the sake of experiment, that it occasioned a general murmur and disgust, and, of course, put a stop to the further exhibition of the *wort* at the hospitals. Orders were then issued to have it given on ship-board, while at sea, where no temptations

tations of fresh vegetables would offer to make the men uneasy, and where it was expected that the patients would chearfully submit.

BUT hitherto *, no return has ever been made to the offices, either of the good or bad effects of the *wort*; whether this hath arisen from disobedience, or inattention, is not easy to determine; possibly, each may have had its share; for, of all men, those who use the sea, are the most averse from innovation and experiment.

BUT nevertheless, as I am now, in consequence of those experiments which have been already made known to the reader, more than ever convinced that the cure of *putrid* diseases in general, and that of the *scurvy* in particular, depends greatly on

* In a letter dated 17th Feb. 1763, which I was favoured with from *Commissioner Tom*, I was told, that at that time none of the navy-surgeons had reported any thing concerning the *Wort*; but Mr. *Tom* engaged to acquaint me of the particulars, as soon as a return should be made to the office.

But as I have never had the pleasure of hearing from that gentleman since (it is now 4 March, 1764), I take it for granted that nothing has been done in consequence of the admiralty's order, nor any report ever made.

the

the quantity of *new air* thrown into the blood from easily fermentable substances, I should deem myself wanting of common humanity if I did not communicate this to the public, and make it my request, that such people as are concerned in long voyages may embrace some opportunity of giving the *wort* a fair trial; for until it is disproved by actual experiment, I shall still continue to think, that this liquor bids as fair to cure the *scurvy* as the juice of any recent vegetable. The experiment can occasion no possible danger, will be attended with very little expence or pains, and, if it succeeds, will make ample amends, in producing a discovery of infinite advantage to the seafaring part of mankind.

If it be true what was published in December, 1762, taken, as is supposed, from returns made to the house of commons, that of *one hundred and eighty-five thousand* men, raised for the sea service, during the late war, above an *hundred and thirty thousand* perished by diseases, and that two thirds of this number may be safely charged to the account of diseases which take their rise from putrefaction; surely, every motive

tive of policy and humanity should excite men to endeavour at finding out something to check this fatal and destructive *disease*; for if seamen could be preserved from it, few other kinds of diseases would endanger them.

For a sea-life, simply considered, is so far from being productive of diseases, that it is found to be a remedy against some of the most dangerous kinds*; and though habitual intemperance, and incautiously exposing themselves to heat and cold, may, and frequently do, cut short the lives of seamen, yet the great mortality to which the crews of the king's ships are too often subject, ariseth from infectious diseases, owing to such numbers being crowded together, and living in circumstances less cleanly than is usual in the merchant's service, where the men breathe a purer air, and are in general cleaner, and better clothed, though by no means better, nor perhaps so well, fed, as in the royal navy.

WHOEVER has read Dr. *Lind's* excellent treatise on the *scurvy*, must be convinced

* See *Gilchrist's* ingenious discourse on the *use of Sea-Voyages in Medicine*.

that the *principal and main predisposing cause* is *too great a degree of moisture* in the *atmosphere*, whether hot or cold, but more especially the latter; and that the use of salt diet, bad water, or foul air, can only be reckoned as secondary causes, which will not of themselves produce the disease.

THE manner in which *excessive moisture* brings on the *putrefactive diathesis*, we have already attempted to explain; and have endeavoured to point out the most effectual methods of preserving the body from its ill effects.

It has been alledged, that this depends very much on keeping the surface of the body always warm and dry, by wearing enough of clean apparel to absorb the *aqueous* part of the perspirable matter; and, at the same time, making use of such diet as will supply a sufficient quantity of *new air*, and which is known, from experience, to correct the morbid disposition, or tendency to putrefaction.

BUT here a question naturally presents itself; where are the bulk of the crew, the poor common sailors and marines, to get such kind of diet? or how are they to be always kept clean, dry, and warm, who,
for

for the most part, have not a second suit, but are obliged frequently to lie down in wet cloaths, and go to sleep in damp hammocks?

To this it may be answered, let the men in the *navy* be cloathed in the same regular, exact, and uniform manner as they are in the *army*; and let them be allowed, *while at sea*, a daily portion of *sugar*; and I will venture to promise, that, in a time of war, we shall annually save some thousands of very useful lives.

WHEN thinking on this subject, I have often lamented, that it has never been attempted to cloath the seamen in this manner. Such a scheme, as it would occasion considerable changes in the present naval system, could not be carried into execution without some difficulty; but if it were once established, it would certainly be productive of great and solid advantages; for it would attach the men more firmly to the service, and prevent a great deal of desertion, by infusing more powerfully that *esprit du corps*, which binds people so strongly together; and it would, without all manner of doubt, render the fleet much more healthy; for the greatest share of

those terrible *putrid* diseases, that sweep off such multitudes of our seamen, take their first rise from a want of necessary cloathing; a species of distress which numbers of people, as things are now ordered on board the king's ships, must often labour under.

THE great importance of necessary cloathing may be plainly seen, by observing what happens to the commission, warrant, and petty officers, on board the fleet; together with such of the common seamen as are careful and provident, and pride themselves upon being always neat and well cloathed. These people are scarce ever seized with *acute* putrid diseases, excepting by mere infection, and they are very seldom known to become *scorbutic*, to any violent degree, unless the *general cause* (excessive moisture) be of a remarkably long continuance.

Now, the diet of all this set of men (the commission, and some of the warrant and petty officers excepted*) is precisely

* If these gentlemen fare better than the rest of the crew, it must be all at their own expence; for the government provides nothing better for the officers than it does for the meanest person in the ship.

the same with the rest of the crew, being nothing better than the common ship's provisions; and many of the petty officers sleep in a part of the ship, where the air must be even more confined than it is where the common men sleep.

THE only circumstances wherein the people of whom we have been speaking usually differ from the common run of the crew, are, that they are *well clad*, and, for the most part, never want a little store of *sugar*.

IT would lead me from my purpose to pursue this matter any further; but the importance of it is so obvious, that I most heartily wish that some person, whose rank in life would insure him the public attention, would take the hint, and offer a plan for the regular cloathing of the seamen in the royal navy; the time being now come when such a thing might easily be attempted: the naval establishment being brought so low, and the several commanders fixed to their ships, for at least some years, will give leisure and opportunity for trying if such a scheme can be carried into execution.

BUT altho' the cloathing scheme should never take place, yet the other part of the proposal may be easily adopted; and I sincerely wish that *sugar* or *melasses* may hereafter be allowed, as a part of *sea-provisions*.

THE expence, even taken at the highest, is too trifling, when put in competition with preserving so valuable a part of the community as our seamen; but I am convinced, that the government would rather be gainers by affording the seamen this allowance; for the savings at the hospitals, which would not then be crowded in the manner they have often been, would more than pay for all the sugar expended *at sea*.

THE reader must have already perceived the principle upon which it is proposed to cure the *scurvy* by the use of *fresh wort*; but as I do not imagine that any person will take the trouble of making the experiment, unless he is almost as fully persuaded as myself, I am under the necessity of entering into a farther explanation of the reasons which lead me to expect that this liquor will produce such salutary effects.

NOT-

NOTWITHSTANDING the many impudent assertions every day published in the common news-papers, which, among other much-boasted remedies, promise not a few as peculiarly specific against the *scurvy* *, yet it may be laid down as a position, not easily to be controverted, that the *genuine, putrid scurvy* has never been known to yield to any other medicines than to such as are composed of *fresh vegetables* †; and provided

* If any of these *nostrums* be *spirituous tinctures*, the material from whence they are extracted, if it ever had any antiscorbutic virtue, must be deprived of it by this manner of treatment; and the tincture itself must be so far hurtful, as every kind of ardent spirit is found to be extremely pernicious in this disease.

If they be *mineral acids*, they are sufficiently known from experience to be useless, either as remedies or *prophylactics*.

But if they contain *mercury*, they must be as so much poison; for mercury breaks down the blood, and destroys its texture, in like manner with the scorbutic acrimony.

† The only places where I meet with any thing like a contradiction to the above assertion, are in *Bisset's Account of the Scurvy*, and in the *History of the Voyages made by the Russians in order to discover the American coasts opposite to Kamtschatka*.

The first-mentioned author thinks that many people were cured at *Cumberland Harbour*, in the island of

provided they be *fresh*, and of such a nature as will allow them to be taken freely, it is almost no matter what they are. The *acid* and the *alcalescent*, the *mild* and the *acrid*, the *sweet* and the *bitter*, all of them cure the *scurvy*; though their sensible qualities be so opposite, and their manner of affecting the body, in ordinary cases, be so different.

THIS virtue, then, *must* be owing to some property which they *all* possess in *common*.

THE experiments of the three preceding essays will, as I apprehend, be allowed conclusive, in shewing that a property, *common to all fresh vegetables*, is, that when mixed with any *animal* substance, and placed in the proper degree of heat, they

Cuba, merely by feeding on *rice*, and before they were supplied with any recent vegetables. (See p. 83 of his Treatise.

And in the last-mentioned book the cure is entirely ascribed to eating the flesh of the sea-cow. But the authors do not take notice, that the same spring-season, and warm weather, that induced these animals to seek the land, must also have thrown up a variety of vegetable productions, which the scorbutic patients would most greedily devour, without waiting for the doctor's directions.

presently

presently run into *fermentation*, and, in the course of that fermentation, throw off an elastic *vapour*, or spirit, of surprising activity, endued with a power of *restoring sweetness* to *putrid* animal fluids.

THIS hath been so clearly and so abundantly proved already, that there cannot be the least necessity for repeating what hath been said of it in the three foregoing essays; I shall therefore only mention some circumstances with regard to the *cure* of the *scurvy*, which will afford almost a demonstration that it depends on the change brought about in the diseased fluids, by the action of the subtile, active, and penetrating spirit, which is generated during the fermentation of the fresh vegetables, carried on in the first passages.

FIRST, the recovery of people in the very *last stages* of the *scurvy*, is brought about in a surprisingly short space of time, provided the patients are but fully supplied with *fresh* vegetables. This is sufficiently confirmed by every account of the *scurvy* that we meet with; and *John Woodall*, an old English surgeon *, who hath left us a very

* Although *Woodall* was a man of great eminence in his

very accurate description of the disease, paints this salutary change in a very striking manner, by saying, " That to any
 " man of judgment it may seeme a won-
 " der, how a poore miserable man, com-
 " ing on lande from a long voyage, even
 " at the point of death, namely, swolne
 " sometimes to an exceeding greatnesse,
 " not able to lift a legge over a straw, nor
 " scarce to breathe, by reason of strong
 " obstruction, yet, in a few dayes, shall

his day, and of no inconsiderable merit as a writer, yet his book appears to be very little known. The only places where I see it mentioned, are in *Wiseman's* preface, and in the preface to *Turner's* surgery; but it is not to be found in *Haller's* catalogue, neither in *Heister's Bibliotheca Chirurgica*; nor, which is still more to be wondered at, in *Lind's Bibliotheca Scorbutica*; notwithstanding that *Woodall* hath left a very excellent discourse on the scurvy, his description of which appears to have been drawn from his own observation, and his method of cure founded on experience, for he served both at sea and in the army. For these reasons, I am persuaded that the reader will be pleased to see an extract from this part of his works, which consists of several discourses on medical, chemical, pharmaceutical, and chirurgicall subjects, printed originally at different times, but all collected by himself, and re-published in a thin folio, in the year 1639, with a dedication to King Charles, under the title of *The Chirurgion's Mate, or military and domesticke Surgery*.

" receive

“ receive the fulness of former health,
 “ yea, with *little or no medicine* at all.”

SURELY this change must be wrought by somewhat of amazing activity; and does not depend on a *saponaceous, attenuating, or resolving* virtue; for in the scurvy the “ *crasis of the blood is broken and destroyed* “ by the *scorbutick putrefaction*,” and certainly never can be restored to a sound state, by being further attenuated and resolved; neither have we sufficient time, in these cases, “ *for the putrefactive acrimony to be diluted, and obviated by the watery and mucilaginous parts, and carried out of the body by the aperient quality of the vegetable juices.*” Nor does the mechanical action of “ *scouring and cleansing the furred and obstructed passages of the machine* *,” at all correspond or agree with the appearances that attend the progress of the cure; which is always found to depend on vegetables only so far as they are *fresh* and capable of yielding a large proportion of *air*; for although the dry *farinacea*, when mixed with the animal juices, ferment very readily, yet both

* See *Lind on the Scurvy*, p. 304, 306.

reason and experiment shew, that they will not do it with so much ease, nor produce so much air, as the fresh succulent vegetables; therefore, notwithstanding that bread, without any other vegetable assistance, will serve, in ordinary cases, to raise the common and necessary alimentary fermentation, and produce enough of the antiseptic vapour to *preserve* the juices in a sound state; yet if a *putrid* acrimony hath once taken place in the constitution, the *crude* and *dry farinacea* are found quite insufficient to conquer it; and there is then an absolute necessity for throwing in a large quantity of *fresh vegetable juice*, in order not only to obtund and sheath the putrefactive acrimony by its mucilaginous quality, but also, by its *fermenting* in the bowels, to generate a sufficiency of the subtile spirit, which seems to be the only thing capable of pervading, in so short a time, the most intimate recesses of the whole vascular system, and of totally changing the corrupted nature of the entire mass of fluids.

SECONDLY, the liquors which have completed their first stage of fermentation, and thereby lost much of their *fixed air*,
though

though they are found useful as preservatives, will none of them *cure* the disease: Cyder, which appears to have a greater degree of antiscorbutic virtue than any of the common fermented liquors, is generally stopped sooner in its career of fermentation, and contains the more *fixed air* on that account*.

THIRDLY, *acids* †, both mineral and vegetable, and *ardent spirits* ‡, which

* See the note in page 147.

Cyder was once carried to sea, as part of the sea-provisions, on the recommendation of Dr. *Huxham*; who finding, "that the juice of apples did most certainly cure the scurvy, imagined, that the same juice, when become a vinous liquor, could not but be very salutary."

The cyder, however, was found to avail but very little, as may be learned from Mr. *Ives's* letter, published by Dr. *Lind*. P. 194 of his Treatise.

It was not at that time suspected, that the antiscorbutic virtue of the apple-juice depended on a principle that must, in great measure, be dissipated, during the action of that fermentation which makes it a vinous liquor.

† "Experience has abundantly shewn, that they (*Sp. Salis, Elix. Vitrioli, and Vinegar*) have not been sufficient to prevent this disease, much less to cure it." *Lind*, p. 187.

‡ This is strongly proved by the remarks of governor *Ellis*, in his account of the Voyage to *Hudson's Bay*.

contain

contain little *fixed air* in themselves, and check the alimentary fermentation, are found to be, the first, useless and insignificant, and the second extremely hurtful, in the disease.

UPON the whole, then, it may safely be repeated, that the *cure* of the *scurvy* depends on the *fermentative quality* in the remedies made use of.

AND this being the case, we have only to find out a substance which may be preserved for some considerable length of time, and yet shall contain materials for raising a fermentation in the bowels like that raised by fresh vegetables; and then, in all human probability, we shall have a remedy for the *scurvy* always in readiness.

SUCH a vegetable substance, it is presumed, is *common malt*.

GRAIN, after it is *malted*, differs widely from grain in the *crude state*; by the germination, drying, and slight torrefaction, its natural viscosity is destroyed, it acquires an agreeable saccharine taste, and the farinaceous part is so attenuated as to be rendered soluble in water.

FRESH wort, or *infusion of malt*, is a liquor similar to the recent juices of the
sweet

sweet vegetables; fermenting readily like them, and being precisely of the same mild, saponaceous, and aperient nature.

WHAT then should hinder it from producing the very same effects? and, as it may be taken in as large a quantity, with as much safety, and with as little disgust, there can be no reasonable objection to its being given. All that remains, then, is to put it to the fair trial; and this I certainly should have done, long ago, if an opportunity had ever presented itself.

BUT the same objections that were made at the naval hospitals, must always be made, as often as the experiment is attempted on shore; therefore, whenever it shall be fairly tried, it must be at sea.

LET me then again request, that such of my readers as may have opportunities, will try the effects of this liquor*: and this is a matter of such importance, as to render it well worth the bestowing of some expence and pains; for if the wort should

* The *East-India Company* would do well to order some malt to be carried out in their ships, and give positive directions to have trial made of its effects, as there never fails to be abundance of opportunities during the course of these voyages.

be found to answer, it will undoubtedly be the means of saving the life of many a brave fellow.

For malt, as I am assured by the brewers, with proper care, may be preserved sound and good for years; so that if it were previously well dried, packed up in small casks, and stowed in the bread-room, or some very dry part of the ship, it might be carried to sea, and kept for any length of time that would be required, even in the longest voyages; and as there need be no very large quantity carried, it would not incommode the ship by its bulk; since I do not mean, that it should be given as a part of the common diet, in the way of preservative, but only to such as are actually sick; when the *malt* is to be ground, and made occasionally into *wort*, as it may happen to be wanted.

THE method in which I would propose the *wort* should be given, is, to boil it up into a *panado*, with the sea-biscuit, or some of the dried fruits that are usually carried to sea; then let the scorbutic patients make at least two meals a-day on this palatable mess, and let them drink a quart, or more, if it shall be found to agree, (always

ways beginning, however, with a smaller dose, and gradually increasing it) of the *fresh infusion*, in the course of the twenty-four hours.

ITS most likely effect will be to open the belly, a most agreeable circumstance to the poor scorbutics (in whom obstinate costiveness is a very common symptom), and exactly similar to the *modus operandi* of the most powerful *green antiscorbutics*.

BUT like them too, if taken too liberally, it may occasion griping, and immoderate purging; when this happens, the dose must be lessened, and some drops of the *acid elixir of vitriol* may be given with it, in order to check the too great tendency to fermentation, and make it sit easy on the stomach.

AND it is not only in the *scurvy*, but likewise in *acute putrid diseases*, that I expect the *wort* will be found of singular service. In all such where the putrefactive acrimony seems to be unaccompanied with any *peculiar pestilential taint*, it promiseth to produce very good effects, from the principles already laid down; for as most of these *simple putrid diseases* arise from an accumulation of sharp and corrupted

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matter,

matter, in the first passages, such medicines as will *dilute*, *obtund*, and above all *ferment*, and, in that action, produce a sufficiency of the *antiseptic vapour* to saturate and sweeten the putrefactive *colluvies*, bid the fairest to give present relief.

IN these cases, the *wort* may make a principal part of the sick person's diet; a thin panado for meat, and the plain infusion, acidulated with lemon or orange-juice, if to be had, if not, with spirit of vitriol, for the common drink.

AND this will bring things as near as the circumstances and situation will allow, to the very successful practice of the celebrated *De Haen*, at *Vienna*. In acute, continual, putrid fevers, his method is truly *Boerhaavian* and *simple*, consisting only in supplying the patients liberally with *oaten* or *barley* gruel, sweetened with honey, and made of different degrees of thickness, according as he intends it for meat or for drink; though, in some cases, they are indulged with flesh broth, made very light and thin. If the belly is not made soluble by the gruel alone, he occasionally mixeth a little *cream* of *tartar*, or *nitre*: His medicines are all of the fresh fermentable

table kind ; *flowers, leaves, succulent-roots,* and *ripe fruits*, made into decoctions, or infusions, according to the nature of the different materials : And his only cordials are decoctions of bread, made palatable by the addition of the more pleasant kinds of fruit, when in season, or, at other times, by the same, preserved, and made into jellies, syrups, or what is usually called *jam* ; with now and then some small doses of the milder *antimonials*, or some of the *neutral salts* : Nor does he ever give his patients any of those trifling and insignificant mixtures which fill up the *German* dispensaries.

By these plain, simple, and pleasant remedies, he finds the extraordinary sickness and nausea, which attend all these putrid fevers at the beginning, is presently allayed ; infomuch, that he scarce ever thinks of giving an *emetic*. The tormenting thirst is so effectually relieved, by these diluent, mild, and saponaceous drinks, that the patients very soon forget to complain of it ; and by their power, likewise, the putrid acrimony which occasioned the disease, is early obtunded and corrected, the disturbed secretions are presently restored to or-

der, and the whole mass of humours preserved from corruption and dissolution: Hence, patients with petechial and miliary eruptions, proceeding from a dissolved state of the fluids, are rarely to be seen in the hospital that *De Haen* has the care of; neither are his patients afflicted with violent vomiting or purging, the acrimonious matter being so early corrected, that even the appetite frequently returns, during the very course of the fever*.

DE HAEN, agreeable to the common theory, makes the virtue of all these things to depend on their producing *acescent chyle*; but how liable this way of accounting for it is to objections, the reader hath already been informed: It is on account of their *fermentative quality*, and on their producing much of the *antiseptic vapour*, that all these things perform such wonders; and if they actually do perform them, there is all the reason imaginable to expect that the *work* will not come far short: I do therefore again most earnestly recommend a trial of it, in the *acute*, as well as in the *chronic*, putrid diseases.

* *De Haen, Ratio Medendi, in capite 1º & 2º.*

IT is known, from certain experience, that all these mild, fermentable substances, will cure a *chronic* putrid disease, as surely as *opium* will procure rest; and, were it not for two reasons, they perhaps would also cure all *acute* putrid diseases.

FIRST, in many of the acute diseases, the acrimony is not *simply putrid*, but is often attended with a certain pestilential principle, which being superadded to the general putrefactive cause, induceth a peculiar morbid disposition, not conquerable by any medicine yet known, but which must depend merely on the vital powers, to concoct and expel it, either in the form of some eruption, or by some critical evacuation.

AND, secondly, even supposing the acrimony to be *simple* and *unaccompanied*, yet the several functions of the body are so early disturbed, and so totally disordered, by the *febrile* commotion, that although the patient be plentifully supplied with such things as would infallibly correct the putrefaction, in circumstances where the digestive organs could turn the remedies to their own proper advantage, yet here they are found to produce no sensible change;

either, because the animal juices have lost their power of raising the natural alimentary fermentation, or the lacteals, constricted by the frebile spasm, obstinately shut their orifices, and refuse admittance even to the mildest and most salutary applications. And hence it is, that *acute* diseases (excepting such as are *purely inflammatory*) are, for the most part, found inflexibly to persist in running through their stated periods, in spite of direct opposite methods of treatment*.

ALTHOUGH I have all along insisted on the *wort*, as thinking it comes the nearest to the *fresh* juices, in every respect, yet, where *malt* is not at hand, I would recommend that *melasses*, *honey*, or *sugar*†, may be

* This constancy of nature, in the progress of some diseases, appears very remarkable in the tertian fevers of Minorca. See *Cleghorn's* excellent discourse on the diseases of that island, p. 149.

† Dr. *Cullen*, who has very sanguine expectations from the *wort*, thinks that *sugar* bids fair to cure the *scurvy*, as well as the *wort*: And it certainly does so; for the same reasons that lead us to expect that the one will prove a remedy, hold good, in almost every circumstance, with regard to the other.

New spruce beer is known to be a most powerful antiscorbutic;

be tried, dissolved in a due proportion of water (about four to one) and given in manner as may be found most agreeable and convenient to the patients.

THE method in which it is proposed to prepare the *wort*, is, to take *one* measure (suppose a quart) of the *ground malt*, and pour on it *three* measures of boiling water; stir them well, and let the mixture stand, close covered up, for three or four hours; after which, strain off the liquor.

It must be brewed, in hot weather especially, fresh every day; for if it be allowed to grow vapid, or sourish, it will not only be unpleasant, but useless, as it would not then run easily into fermentation; but

tischorbutic; but this virtue seems to depend chiefly on the melasses that is mixed therewith in order to make it ferment; for I apprehend that a decoction of *dried* fir-tops, alone, would no more cure the *scurvy*, than the decoction of any other dried vegetable, great variety of which have been tried, but always without success.

Honey, on the same principle, must be a good antiscorbutic, and, as such, may be recommended to officers, and others who can carry it conveniently, to eat some daily, which would, in all probability, keep off the extreme costiveness to which people at sea are so very liable.

when perfectly fresh, there cannot well be a more palatable kind of drink, and I dare say, that, in general, it will sit light and easy on the stomach.

If what hath been urged shall be found of sufficient weight to engage any gentleman in a trial of the *wort*, all that I have further to request, is, that he will, previous to its administration, carefully and particularly note down the cases in which it is given; describing with accuracy the several symptoms, and relating fairly, and with candour, the progress and effects, from time to time; and let these observations be communicated, either to the public at once, or to the author at *Dublin*.

A P P E N D I X.

A N

EXTRACT from that Part of Wood-
ALL'S WORK which treats of the
SCURVY.

HE prefaceth his discourse on the
scurvy with lamenting, " That
" none of his countrymen had, out of
" their experience, taken in hand sincerely
" to set down to posteritie the true causes,
" signes, and cure thereof; neither left
" any caveats, instructions, or experiences,
" for the prevention or cure of the same."
He therefore declares his intention " of
" informing the chirurgeon how he should
" demean himself, to comfort his patient
" at sea, in that most dangerous disease;"
which, he tells his reader, " is a disease of
" the spleene, whereby it is sometimes
" wholly stopped, and sometimes only dis-
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HAVING bestowed a paragraph or two on the different names of the disease, he goes on to treat of the causes, signs, and method of cure, expressing himself in the following terms.

“ THE causes are so infinite and unsearchable, as they far exceede my capacity to find them out: Some men conceive this disease happeneth unto seamen only through their being long at sea without touching at land, as at their coming on land they presently grow strong again, and are, by the very fresh aire, and fresh food, cured, without much other helpe. The chief cause thereof is the continuance of salt diet, which is not to be avoyded at sea, want of sufficient nourishment, and of sweete water; and also for want of *aqua vita*, wine, beer, or other good water, to comfort and warme their stomachs withall.

“ ANOTHER cause of this disease, to the ordinarie sorte of poore men, is want of fresh *apparel* to shift them with; which, indeed, among poore sailors, especially a sorte of them that are careless and lazie of disposition, is too frequent;

"quent; partly also by not keeping their
 "apparell *sweet* and *dry*, and the not
 "cleansing and keeping their cabins sweet;
 "this also ingendreth and increaseth the
 "infection. Some charge bisket as a cause
 "of the scurvy, but I am not of their opi-
 "nion; some say inordinate watchings are
 "the cause thereof; some say, extreme
 "labour, wanting due nourishment; some
 "also affirm cares and grief to be the
 "cause thereof; others affirm, the very
 "heat of the aire, resolving the spirits.
 "But what shall I amplify farther? for it
 "is also true, that they which have all the
 "helpes that can be had for money, and
 "take as much care as men can devise,
 "are, even by the *evil disposition* of the
 "aire, and the course of nature, strooke
 "with a *scurvie*, yea, and die thereof, at
 "sea and land both.

"THE signes of the scurvie are many;
 "as, namely, a general laziness and evil
 "disposition of all the faculties and parts
 "of the bodie, saving the stomach and
 "appetite, which oftentimes is greater
 "than ordinarie, with them, for a long
 "time,

" A DIS-

“ A DISCOLOURING of the skin, as if
 “ it were fouler than ordinarie, with spots
 “ darker coloured than the rest, and some-
 “ times also darkish blew spots.

“ A FEVER at sea commonly ends in
 “ the scurvy; wherefore, beware of too
 “ large bleeding, which oft increaseth the
 “ grieve and maketh it incurable.

“ ALSO itching, and aching of the
 “ limbs, are signes of the disease.

“ SOMETIMES, also, the legges falling
 “ away and drying, and the calves of the
 “ legges growing hard and dry; as also
 “ immoderate swellings of the legges.

“ ALSO the legges and thighes dis-
 “ coloured into frekells or spots, of a dirty,
 “ brown, sad colour, much like the co-
 “ lour of a gangrenated or mortified
 “ member.

“ STINKING of the breath, greate ob-
 “ structions of the liver, or spleene, or
 “ both; and, in the exercise of their bo-
 “ dies, their limbs and their spirit failing
 “ them.

“ SHORTNESSE and difficultie of breath-
 “ ing, especially when they move them-
 “ selves, but lying still, find little grieve
 “ or paine.

“ THEIR

“ THEIR eyes of a leady colour, or like
“ dark violets.

“ GREAT swellings of the face, legges,
“ and all over the body; paleness, or a
“ foul pale colour in the face; swellings
“ in the gums, rottenesse of the same,
“ with the issuing of much filthie blood,
“ and other stinking corruption thence;
“ loosenesse of the teethe: Also some are
“ troubled with extreme costiveness, that,
“ for fourteen days together, they go not
“ to stoole once; also many have stop-
“ pings of the urine, or, at the least,
“ making less water in two days than the
“ partie drinketh in one.

“ A COLDNESSE and stiffnesse of the
“ finewey parts chiefly of the legges; some
“ also have their muscles, yea, and the
“ finewes of their thighes, arms, and
“ legges, so wasted away, that there seem-
“ eth to be left only the skin covering the
“ bones.

“ ALSO it is manifest, that diverse of
“ those which have been opened after
“ death, have had their livers utterly rot-
“ ted; others have had their livers swolne
“ to an exceeding greatnesse; some, the
“ spleene extreamly swolne; others have
“ been

“ been full of water ; others have had the
“ lungs putrified, and stunk whilst they
“ have lived.

“ THESE and diverse other signes, too
“ many for to be mentioned here, do af-
“ flict poore seamen, which are often past
“ man’s helpe, in such time and place as
“ they happen; the cure whereof only
“ resteth in the hands of the almightie.”

AFTER mentioning *Ectbius* and *Vierius*
as writers on the disease, and taking notice
of the indications of cure as laid down
by them, he says, “ he may spare his
“ labour, in writing what broths or
“ herbes can serve best, where no freshe
“ food can be gotten :” He therefore goes
on to direct the use of such things as are
usually carried to sea; namely, “ wine,
“ sugar, spices, and other comfortable
“ things, which the chirurgion ought to
“ take care that the men have in due sea-
“ son ; and, moreover, he ought, morn-
“ ing and evening, to seeke for poore and
“ weake men in their cabins, or, so soone
“ as they are missing at their messes, to
“ enquire for them, and see that their ca-
“ bins be sweet, and their provisions ac-
“ cording.

“ AND

“ AND whereas the first part of this
 “ cure is in opening obstructions, it is
 “ therefore fit, in the beginning of the
 “ grieve, to give an opening clyster; then
 “ the next day, if the party be strong,
 “ open a veine; but beware, as is said, of
 “ taking away too much blood at once.”

“ If the disease be attended with swelling
 and fullness, he advises a purge, and then
 orders to make the patient some comfortable
 spoon-meat, namely, “ an oatmeal
 “ caudle, with a little beer or wine, the
 “ yoke of an egge, and some *sugar*; or a
 “ broth, made with currants or other
 “ fruite, with spices and *sugar*; and, for
 “ drink, barley water, with some juice of
 “ lemons, if it may be had, if not, with
 “ oyle of vitriol and *sugar*. *But evil*”

“ THE juice of lemons is a precious
 “ medicine, and well tried, being found
 “ and good; let it have the chief place,
 “ for it will well deserve it. It is to be
 “ taken twice a-day, a spoonful or two
 “ with *sugar*.” In want of it, or the
 the juice of *limes*, oranges, or citron, or
 the pulp of tamarinds, give “ oyle of vi-
 “ triol, as many drops as will make a cup
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 the juice of *limes*, oranges, or citron, or
 the pulp of tamarinds, give “ oyle of vi-
 “ triol, as many drops as will make a cup
 “ of beer or water sower a little, as it
 “ were,

“ were, and add *sugar*, or some syrup: A
 “ decoction of *bisket*, and therein almonds
 “ ground, with *sugar*, and a little *cinna-*
 “ mon or rose-water, is a very comforta-
 “ ble drink to be taken now and then to
 “ refresh the stomach.”

He proceeds then to give directions how to sweat the patients, and how to relieve extreme costiveness; next, he directs lotions for the rotten gums, and orders the swelled limbs to be fomented with a weak lixivium, boiled up with some of the discutient and warmer kind of herbs, and afterwards to be rubbed with particular ointments that he mentions.

In the cure of scorbutic ulcers, he remarks, that “ until the obstructions in the
 “ liver and spleene, be removed, these
 “ ulcers give no place to good healing;”
 and therefore advises “ all sharp and vio-
 “ lent medicines to be shunned, and no-
 “ thing but soft and anodyne things to be
 “ applied, for otherwise, you will not only
 “ strive against the streame, but put your
 “ patient to needless disquiet, and thereby
 “ increase his disease.

“ A *POULTICE* of *bisket*, boiled up in
 “ beere or wine, applied warm, will won-
 “ derfully

“ derfully comfort a weak limb, and as-
 “ swage pain : But fattie things must be
 “ forborne in some cases ; namely, when
 “ the pain is sharp and quick, lest you
 “ cause putrefaction and suppuration of
 “ the humours against your will ; yea,
 “ and rather use acetous medicines and
 “ anodynes.”

THIS extract shews that *Woodall* was a man of some observation.

THERE are many good things for the time he wrote. In other parts of his book, his method of treating wounds, both common and gun-shot, was judicious and simple ; his dressings being, for the most part, very plain, chiefly dry lint, and he condemns the use of tents and escharotic applications.

WITH regard to fractures, he was an enemy to long rollers, or tight bandages.

WHEN he amputated, he often made use of the cross-stitch, to keep down the flesh over the end of the stump ; and he knew how to restrain the bleeding, by tying the vessels.

HE was the inventor of the *trefine*, which he so named from its three extremities, (*a tribus finibus*) each serving a different

ferent purpose; and he was the first man who introduced the *enemata fumosa* *; proposing also to throw up, in this manner, powders, and the like, into the intestines, in order to cure obstinate fluxes, and other diseases of those parts.

* It may not be amiss in this place to inform the reader, that I have found, upon trial, that *tobacco-smoke*, thrown up in the way of clyster, effectually and immediately destroys the *ascarides*. And this I was induced to try upon the recommendation of Mr. Turner, surgeon, at *Liverpool*. See his letter to Dr. Fothergill, in the second volume of the *London Medical Observations*.

ESSAY

ESSAY V.

ON THE

DISSOLVENT POWER

OF

QUICK-LIME.

APPENDIX

There are agents in nature able to make the particles of bodies stick together by very strong attractions; and it is the business of experimental philosophy to find them out.

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NEWTON.

QUICK-LIME

ESSAYS V.

ON THE DISSOLVENT POWER OF QUICK-LIME.

THE experiments of the second and third essays have sufficiently shewn, that the cohesion of animal and vegetable substances depends *immediately* on the *fixed air*; but how far the influence of this principle extends into the mineral kingdom, is not yet certainly known.

HALLER seems to think that it is very general, being here also the *vinculum*, or *gluten verum moleculis terreis adunandis**; though it does not appear that he has any actual experiment of his own to confirm this hypothesis.

BUT since the publication of Dr. Black's most ingenious paper on the *magnesia*, we

* *Prim. Lin. sect 244.*

cannot help being convinced that the theory holds good, at least with regard to the class of bodies which he hath examined; to wit, the calcareous earths.

THE reader may remember, that the doctor's theory of calcareous earths is, that these bodies have a very strong degree of affinity * with fixed air, and, in a natural state, are replete with it; that by calcination they are deprived of this element, and hence become caustic and soluble in water; but that, upon restoring the fixed air, they are again rendered mild and insoluble.

ALL this is very satisfactorily shewn in the essay above-mentioned; but it occurred to me, that it might possibly be still further proved, and that in a way which would afford an ocular demonstration. I thought that perhaps the dissolved quicklime might be rendered visible, and would precipitate upon transferring *fixed air* into *lime-water* †.

EXPE-

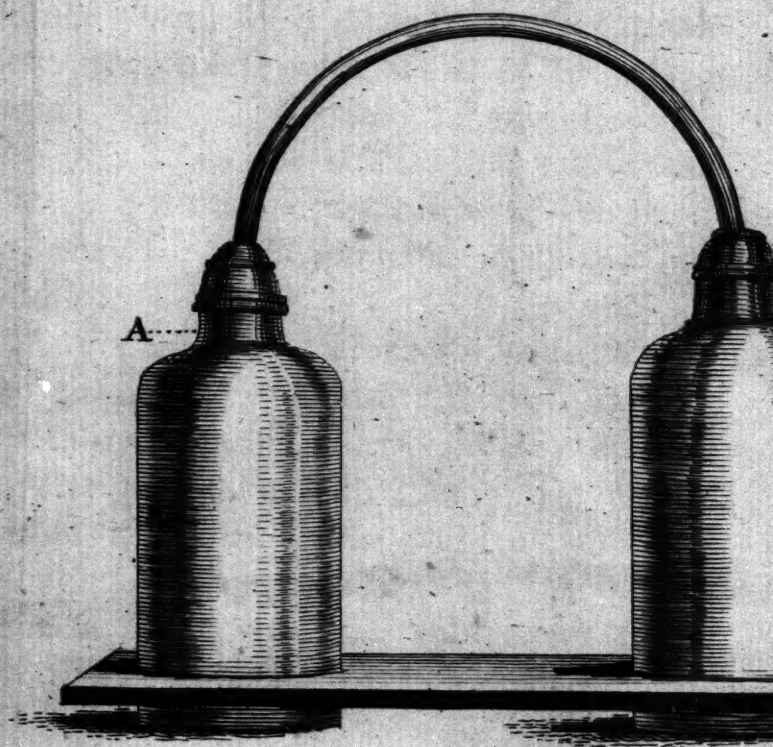
* And fixed air has a stronger affinity with calcareous earth than with any other substance yet known.

† In the manner described in the second essay, and 10th experiment.

When

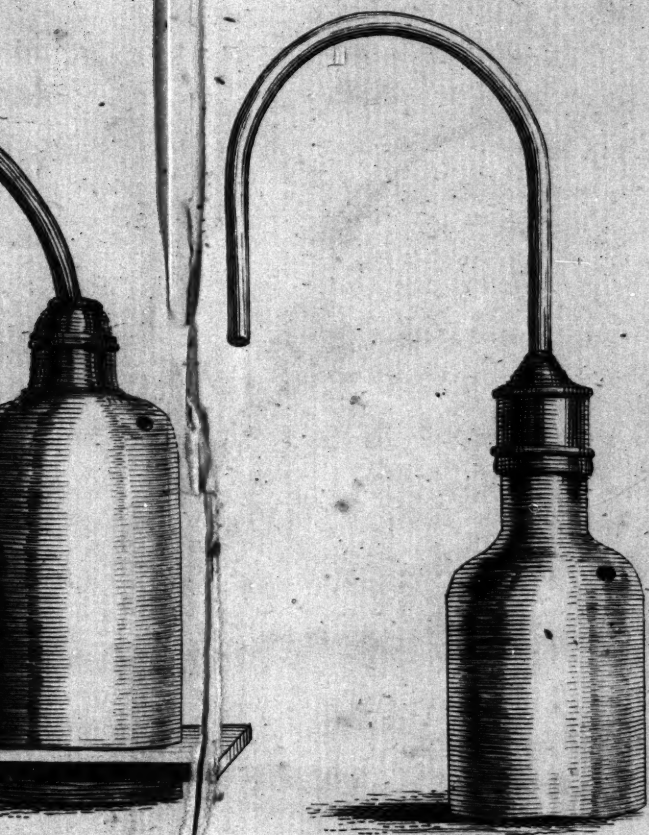


Fig. 5.



facing p. 215.

Fig. 4.



EXPERIMENT 1.

I PRESENTLY set about the experiment, and found it answer fully to my expectations; for the lime-water, which was filtered, and perfectly limpid, became turbid in a few minutes after the effervescence began, and that the air which was extricated from the mixture of acid and alkali, had passed over into the phial containing it. And it was highly pleasing to see the particles of the quick-lime, which, but

When I found that by transferring air into different bodies, a variety of curious changes were produced, I laid aside the glass tube, and had an apparatus prepared which rendered the performance of the experiments more easy. I caused a metal tube to be fixed on by a screw to the neck of a phial, as represented in fig. IV. which tube could be occasionally inserted into the mouth of another phial, being previously wound about with soft leather, in order to prevent the escape of the factitious air.

But a very ingenious friend, who is remarkable for his skill in every part of natural philosophy, but particularly mechanics, improved it further, by contriving the machine in fig. V. In the neck of the bottle A, which is the recipient, there is an *air-valve*, which allows the air to pass into the bottle, but prevents its return; and this I found greatly to shorten and facilitate the process.

two or three minutes before, were quite invisible, and dissolved in the water, all running together, and falling to the bottom, having returned to their original state of insolubility, the moment they were saturated with the fixed air.

WHEN the turbid mixture had stood long enough to allow the precipitate all to subside, I poured off the clear, and found some grains of calcareous earth, which effervesced violently with spirit of vitriol.

AND thus was the theory of Dr. Black placed beyond the reach of contradiction; since we must here be convinced, from what is seen to pass before our eyes, that the quick-lime became *soluble* in water from the want of its fixed air, because we find it grow *insoluble* the moment the *cementing principle* is restored.

FINDING, by the preceding experiment, that the lime, though so minutely divided, and so intimately mixed with the water, as to be reduced to a state of actual fluidity, might nevertheless be rendered solid, and brought immediately into view, by restoring the cementing principle, I began to think, that, by introducing air into the

the natural sulphureous waters, as I had done into the lime-water, the sulphur might be rendered visible, as I conceived that this dissolution of the sulphur possibly may be brought about in these waters, from its being some way or other deprived of its fixed air.

BUT as I could not immediately procure a natural sulphureous water, I resolved to try the experiment with an artificial one.

EXPERIMENT 2.

IN order to do this, I boiled up some flowers of sulphur with water and quick-lime (as directed for preparing the *sulphur præcipitatum*); and having filtered the solution, which made it perfectly transparent, I put about four ounces of it into the phial used in the foregoing experiment, and transferred the air from an effervescent mixture contained in the other phial.

THE sulphureous did not so soon lose its transparency as the lime-water, but, in eight or ten minutes, a scum formed on the surface; and the whole solution immediately after becoming turbid, I could plainly

plainly perceive the solid particles collecting themselves together.

WHEN I thought that there was a sufficient quantity of air thrown in, the phials were separated, and the turbid contents of the first one poured into a tall drinking-glass. The liquor now sent forth the strong and peculiar smell which solutions of sulphur always yield, when an acid is added to them.

EXPERIMENT 3.

HAVING soon after got some bottles of the *Lucan* water *, a few ounces of it were put into the phial, and air transferred from an effervescent mixture, as in the two preceding experiments; but notwithstanding a slight degree of milkiness appeared at first, yet no precipitation ensued.

THESE experiments, however, pointed out a method of making a pure solution of sulphur, which being diluted to the proper degree, gives an artificial sulphureous water, perfectly resembling the natural, as to taste, smell, transparency, and

* *Lucan* is a village within six miles of *Dublin*, where there is a spring of sulphureous water.

want of colour, and not liable to grow turbid on the addition of acids, which all other artificial solutions of sulphur, hitherto known, constantly do.

THE turbid solution of lime and sulphur, as hath been already mentioned, was poured into a tall glass, and happening not to be thrown out, I found, after standing thirty-six hours, that it did not become limpid, though I could plainly perceive a quantity of lime lying at the bottom, while the yellowing fluid remaining above, evidently shewed to be an equable and true solution of sulphur, now left perfectly alone in the water: I immediately saw that there was nothing more to be done here than dilute this solution to a proper degree, and that it would then constitute a true sulphureous water.

EXPERIMENT 4.

UPON trial, it actually did so; and although this present solution, from being so long exposed to the open air, had lost much of the strong and peculiar sulphureous smell, yet I found, on repeating the experiment, that a solution, fresh-made, and the lime, immediately separated from
it

it by the introduction of air, and then diluted, so as to leave the liquor colourless and transparent, yielded a water so nearly resembling the latter, that, as to smell, taste, or appearance, it was hard to perceive any difference.

BUT upon dropping *lixivium tartari* into the artificial water, it instantly grows turbid*; whereas, when the like addition is made to the natural sulphureous waters, their brightness is improved; which shews that the solution of sulphur, in the natural waters, is brought about in some manner not analogous to that in the artificial; for it seems pretty obvious, that the sulphur is here rendered soluble in water, from being deprived of its *cementing principle* by that share of the quick-lime which remains undissolved in the boiling.

THIS presented a new theory concerning the solubility of oil, when combined with

* On mixing the fixed alkali with the sulphureous water, the peculiar sulphureous smell is instantly changed to one which is rather more disagreeable, and though the mixture becomes turbid, yet no precipitation ensues; the sulphur and the alkali, joining into a body, separate themselves from the water; and remain suspended in the glass.

the caustic alkali, and made into soap; which, I conjectured, might, as well as the sulphur, be rendered miscible with water, when the cohesion of the oily particles is destroyed, by the loss of their fixed air.

EXPERIMENT 5.

THIS conjecture was found to be right, by transferring air, from an effervescent mixture, into a solution of common soap; for the moment the air mixed with the solution, the oily part began to separate, and, in a few minutes, all rose to the surface, the cementing principle now being restored to the disunited particles of the oil.

I REPEATED this experiment on a solution of soap, which was filtered, and kept above a week after it was made; so that there could be nothing of a spontaneous separation in either case.

THESE experiments opened the way to some improvements in *pharmacy*; since it followed plainly, that if oil was thus rendered miscible with water, *camphor*, and all kinds of *resinous bodies*, might, in like manner, be dissolved.

EXPERIMENT 6.

I BEGAN with the camphor, and having rubbed a drachm of it with an equal portion of quick-lime, and then poured on six ounces of lime-water, I allowed the mixture to stand for half-an-hour, that the gross and insoluble part might subside; the clear was then passed through a filter, and found to be a strong solution, containing at least one half of the camphor.

ON another occasion, I made use of heat, boiling the camphor and quick-lime with water in a close vessel, and thus obtained an entire solution.

THESE solutions, when filtered, are perfectly limpid, and never part with the camphor; for though the lime may be precipitated in several ways, yet I have not hitherto hit upon any method of separating the camphor from the water.

COMMON salt, if added in a large proportion to the solution, throws up a cream to the surface, which, upon examination, is found to consist of little more than mere calcareous earth.

AND ardent spirits, though they cause a milkiness when added to the solution, do

not

not entirely part the *camphor* from the water.

EXPERIMENT 7.

MYRRH, *gum guaicum*, *asa fætida*, *aloes*, *castor*, *balsam of Tolu*, with *mastich*, *jalap*, and the *cortex*, were all tried in the same manner as the *camphor*, and were found to yield strong solutions and tinctures, the lime appearing to take up the same part of these substances that is dissolved by the means of ardent spirit. But these aqueous tinctures must be much more elegant medicines, and perhaps may be found more efficacious than the spirituous ones, on account of the extremely minute division of their more active part, as well as their convenient exhibition, since they will never become turbid, or separate, on being mixed in any watery vehicle.

THERE is as much lime in all these tinctures and solutions, as there would be in the like quantity of lime-water, which bids fair to improve the virtues of some of them, and can do no great injury that I know of to any; but if it should ever be thought so, the lime may be precipitated from them, by throwing in air from some effervescent

effervescent mixture, as hath been already explained.

THE air, when thus thrown in, renders the solution, or tincture, quite turbid, and appears plainly to the eye, at first, to reunite the dissolved particles of the resin, as well as the lime; but the former are very soon re-dissolved, and the lime only falls to the bottom.

As the fixed air, when thrown off by putrefaction, or during the first stage of fermentation, equally produced the effect, of rendering *mild* the *caustic* alcali, with that which was set free by effervescence, it might have been fairly concluded, that it would also precipitate the lime from lime-water; but as I had laid it down for a rule to depart as little as possible from actual experiment, and to be very sparing in drawing conclusions from any thing but evident facts, I determined to make the trial.

EXPERIMENT 8.

ACCORDINGLY, having joined two phials together, by means of the bended glass tube, (as in the 17th experiment of the second essay), and filled one with fresh
mutton,

mutton, and a little water to make it putrefy the sooner, and the other with lime-water, I laid them by in order to let the putrefaction proceed.

BEFORE twenty-four hours were elapsed, the precipitation of the lime was evident, and it increased every day, for six days that the phials remained in this situation; but shaking the phials one day, in order to make the putrid liquor subside (for it rose in the tube in the same way that it did in the experiment before-mentioned, when I was transferring air from putrid flesh into the caustic alcali), the tube happened to break, and an end was thereby put to the experiment; but I had seen enough to prove that *fixed air*, when thrown off by *putrefaction*, would produce the very same effect on lime-water with that which was set free by *effervescence*.

AND here we have an additional proof of the *fixed air*'s being the *cementing principle* in *animal substances*; since we see, that while the flesh is resolved, and falls in pieces, from the loss of this principle, the lime is rendered solid by having it restored.

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WHILE this experiment, and the following, were going on, I filled two phials with filtered lime-water (that used in the experiments was always filtered), and left one of them without a cork, while the other was closely stopped, and laid them by as standards; to see if any, and in what proportion, the lime would precipitate when left to itself: But neither the one, nor the other, in a fortnight's time, deposited the smallest particle of lime.

EXPERIMENT 9.

IN order to try the effects of the gas, or vapour, discharged during the first stage of fermentation, I made up six ounces of a fermentative mixture, of flesh meat, bread, cabbage, and turneps, with the requisite quantity of water, and put it into one phial; which being joined, by means of the tube, to another filled with lime-water, the two were placed in a temperate degree of heat, that the mixture might ferment the sooner.

THE fermentation began in the usual time, and went on with the common appearances: And as it did proceed, the lime became every day more and more visible;

sible; and forming, first, light flakes of a feathered resemblance, near the surface, these gradually fell to the bottom, until, at the end of five days (the period that the phials remained in conjunction) when I poured out the water, and allowed the precipitate all to subside, I collected three grains of calcareous earth from six ounces of lime-water, which was the quantity contained in the phial.

THIS action of the vapour (which, on a former occasion, was termed antiseptic) in re-uniting the dissolved and scattered particles of lime, may serve to give some idea of the manner of its operation on dissolved blood, when the texture of that fluid is destroyed and broken, by a putrefactive acrimony.

AND this experiment likewise shews, that lime-water, when given as a *lithontriptic*, ought not to be drank at meals, lest it lose part of its virtue, from the fixed air of the alimentary substances saturating and rendering inert, the dissolved and active particles of the quick-lime.

THE activity of lime-water must also be impaired by infusing vegetable substances therein, which contain much fixed air;

such as the *guaicum*, or *sassafras*; for these woods abounding in resin, give out their cementing principle, which, uniting with the dissolved quick-lime, restores it to its original state of an inactive calcareous earth: Therefore, when it is intended that these woods, or any other substance of the like nature, should give out their virtue to lime-water, and that the water should, at the same time, contain its due proportion of dissolved lime, some quick-lime ought to be added, during the time of maceration.

WE have seen, then, in *three* different instances, that the lime is precipitated from lime-water by restoring to it the fixed air: May not lime-water, therefore, upon this principle, be used as a *test* to try whether or not bodies contain *fixed air*? If any body, upon mixture with lime-water, occasions a precipitation, and if the precipitate so caused effervesce with acids, may we not conclude that the body so added contains fixed air; and that, in a greater or smaller proportion, as the precipitation of the lime from the water is more or less immediate?

EXPE-

EXPERIMENT 10.

SPIRITUS *cornu cervi per se*, salt of *hartshorn*, and salt of *tartar*, being severally mixed with lime-water, immediately threw down a precipitate, which, upon examination, was found to be true calcareous earth.

EXPERIMENT 11.

SPIRIT of *sal ammoniac*, made with quick-lime, and the *caustic alkaline ley*, made of pot-ash and quick-lime, when mixed with the lime-water, did, neither of them, in the least destroy its transparency, nor did any precipitation ever ensue.

EXPERIMENT 12.

BUT air being transferred into the same caustic alcalies, and lime-water then mixed with them, the same appearances followed, which happened upon mixing the mild alcalies in the 10th experiment.

EXPERIMENT 13.

BROWN sugar *, when mixed with lime-water, presently threw down a precipitate, which effervesced violently on the addition of spirit of vitriol; but refined sugar (which is deprived of great share of its fixed air, by the quick-lime that is used in refining it), when dissolved in lime-water, did not at all destroy its transparency, and, after standing twenty-four hours, threw down scarce any precipitate.

EXPERIMENT 14.

RECENT juices of fruits, or other vegetable substances, when mixed with lime-water, destroyed its brightness immediately, and soon after threw down a precipitate, which effervesced violently on the addition of spirit of vitriol. But fermented liquors occasioned no immediate change, nor did any precipitation ensue until after several hours standing, and this different

* Dr. Hales found the proportion of air, in the coarsest sugar, to be a little more than one-tenth of the whole. See his 65th experiment of the 1st vol.

in different liquors*: Then, also, the quantity of precipitate was but small, the whole of the lime not being saturated, as the taste plainly testified was done by the recent, unfermented juices.

EXPERIMENT 15.

ARDENT spirits † produced still less alteration on lime-water, than the fermented liquors; but they absorbed the air from an effervescent mixture very greedily, and, when thus charged, threw down the lime from the lime-water instantly on being mixed therewith.

THESE experiments all concurring to establish lime-water as a *test* of the presence, or absence, of fixed air, I resolved to examine some of the animal fluids, in this manner.

IN Dr. *Whytt*'s very ingenious essay on the virtues of lime-water, we find a number of experiments, made with a view of determining what things impair or destroy its dissolvent power, with regard to the

* Cyder and bottled beer threw down the precipitate much sooner than claret or port-wine.

† It was rectified spirit that was tried.

calculus; one of which plainly shews, that the urine contains fixed air; for when this celebrated professor mixed “ an ounce and
 “ a half of lime-water, and an ounce of
 “ fresh-made urine, it immediately lost its
 “ yellow colour, and became whitish and
 “ turbid, and, in a little time, a light,
 “ white sediment fell to the bottom, and
 “ left the liquor above perfectly pellucid,
 “ of a fine light lemon colour, without
 “ any scum or crust on the sides of the
 “ glass *.”

EXPERIMENT 16.

I REPEATED this experiment with precisely the same appearances; and found, that on pouring off the clear, and dropping in spirit of vitriol, a violent effervescence ensued; plainly shewing, that the particles of the quick-lime, now saturated with the fixed air, which they had absorbed from the urine, were returned to their original state of a calcareous earth.

WE have already hinted, that there is some danger of lime-water's being deprived of part of its virtue, from the vapour aris-

* See the Essay, sect. 2. No. 8.

ing from the alimentary substances, during their fermentation in the first passages; and here we have another circumstance which is discouraging, with regard to the dissolution of the *calculus*. By the experiments hitherto made, the *calculus* appears capable of dissolution in *two* ways; either by means of a strong acid, such as spirit of nitre, which probably acts immediately on the earthy part of the stone, or by lime-water, or caustic alkali, absorbing the fixed air; whence the earthy parts, deprived of what bound them together, must presently fall to pieces*.

WITH regard to internal exhibition, the *acid* is entirely out of the question, and the only hope of a safe dissolvent must rest on the *caustic alkali*, or on the *lime-water*.

THIS alkali, when combined with oil, and made into *soap*, is not only so greatly obtunded thereby as to lose much of its power, but the soap itself is so nauseous, that few patients can bring themselves to

* Of all the various substances examined by Dr. Hales, with a view of determining their respective quantities of air, the human *calculus* was found to contain the largest proportion; above one half of this mass consisting of *fixed air*.

take it in a quantity so large as to prove of much effect ; it would therefore be a happy discovery if any vehicle could be found out, that would sufficiently sheath the acrimony of the caustic alkali, so as to allow it to be taken in large and continued doses : Possibly, veal broth, or a decoction of marsh-mallow roots, might be found to answer this purpose ; and lime-water might be taken at the same time, which would not at all interfere with the operation of the alkali, but rather add to its activity.

LIME-WATER, when taken alone, must often fail in producing any considerable effects as a *litbontriptic*, because it must lose much of its power, not only from the vapour it meets with in the first passages, but likewise from the fixed air of the urine itself, which must saturate great share of the quick-lime, even when it hath reached the bladder.

THAT this actually happens, may be inferred from the great quantity of earthy matter discharged in the urine of persons who are under a course of lime-water ; this sediment seeming to consist mostly of lime, parted from the water in which it was

was dissolved, being precipitated by the fixed air of the urine.

It should seem, then, as if the caustic alkali bade the fairest for success in these cases; and therefore its effects should be tried in hospitals, and, as hath been already mentioned, it should be given in some gelatinous, or mucilaginous vehicle, that would sheath the sharpness of the salt, in such manner as to allow of a considerable quantity being taken; which certainly might be accomplished, since we find that Dr. *Jurin* brought himself, by degrees, to take an ounce and a half of capital soap lees, in the course of a day, though diluted by liquors that had little or nothing of the mucilaginous nature*.

* There is a paper in the Gentleman's Magazine for October 1763, which proves very plainly, that a nostrum, exhibited by one Dr. *Chittick*, and which is found, after a perseverance of some months, actually to dissolve the stone, is nothing more than the caustic alkali, given in veal-broth. The patients prepare the broth themselves, and send it to the doctor every day, who returns it with the medicine mixed therein.

EXPE-

EXPERIMENT 17.

THE *perspirable matter* also contains fixed air: Three ounces of filtered lime-water being put into a phial, and a funnel fixed close into the neck of it, I blew in my breath through the funnel, and by the time I had continued so doing for ten or twelve minutes, I found the water growing turbid, and the lime becoming visible.

THIS being a tiresome kind of operation, I desisted, when I had thoroughly satisfied myself that the *perspirable matter*, if thrown in in a sufficient quantity, would saturate all the lime, since even what I had done was found, upon collecting the precipitate, to have thrown down more than a grain.

I FOUND also that *sweat* contains fixed air, and used the following method of collecting some drachms of this fluid.

EXPERIMENT 18.

HAVING often observed hackney-chairmen sweat so profusely after setting down their fare, that they sweep it off from their bare heads in a full stream with their leathern straps, I took an opportunity one day

day of collecting about a couple of drachms of sweat, that had been raised in this manner, and having mixed it with six drachms of lime-water, found that the mixture immediately became turbid, and, in a short time, deposited a light sediment, such as was thrown down from the urine, and which effervesced as violently when spirit of vitriol was added.

I HAD formerly ventured to assert, that air is thrown off from the fluids by perspiration, and these experiments, I apprehend, will readily be allowed as proofs of the truth of that assertion.

BUT the *saliva* seems as if it contained little or no fixed air; for when Dr. *Whytt* infused a piece of *human calculus*, weighing three grains, in a mixture of *saliva* and lime-water, in the proportion of one of the former, to two and a half of the latter, in two days warm digestion, the bit of *calculus* was reduced to one grain and a half*.

THAT is to say, the lime-water having lost scarce any thing of its power, the *calculus* dissolved as readily, in a mixture of

* Sect. 4. No. 21.

saliva and lime-water, as it would have done in lime-water alone, equally dilute; for had the *saliva* abounded in fixed air, which would have saturated the quicklime of the water, its dissolvent power would have been proportionably weakened, as we find it was by mixing fresh vegetable juices, or honey, with lime-water*.

EXPERIMENT 19.

Two drachms of *saliva* being mixed with six drachms of lime-water, the mixture did not grow turbid; but in two hours I found a sediment, which, on pouring off the clear, and dropping in spirit of vitriol, shewed little or no sign of ebullition. Hence I concluded, that this sediment was scarce any thing more than the gross part of the *saliva*, which, when left to itself, in a little time deposits a considerable portion of thick and viscid matter.

* See Dr. Whytt's Essay, sect. 6 & 7, Nos 34, 36, 37, & 38.

EXPERIMENT 20.

I THEREFORE resolved to repeat the experiment, and having collected near an ounce of *saliva*, and suffered it to stand long enough for the thick part to subside, I then mixed two drachms of the clear with six drachms of lime-water, and found it produce no immediate alteration.

BUT two drachms of the same clear *saliva* being put into a small phial, and air transferred into it from an effervescent mixture, and then mixed with six drachms of lime-water, instantly the mixture became turbid, and a large quantity of precipitate, in the form of flakes, fell to the bottom, and effervesced violently when spirit of vitriol was poured on it.

THE first mixture of lime-water and *saliva*, after standing twenty-four hours, was covered with a crust, and found to have deposited but a small quantity of whitish viscid matter, which effervesced but slightly with the acid spirit.

So

So that the *saliva* naturally contains very little fixed air, but, nevertheless, is a powerful absorbent thereof*.

FROM another experiment of Dr. Whytt's, the bile appears to contain as little fixed air as the *saliva*; for when he immersed a fragment of *calculus*, weighing three grains, in an ounce of cystic bile, and three ounces of oyster-shell lime-water, and kept it in a moderate heat for forty-two hours, he found that near a grain and a half of the substance of the *calculus* was dissolved in the form of thin whitish scales†.

* We had a former proof of the affinity between *saliva* and fixed air, in the 14th experiment of the second essay; wherein it was found that the *saliva*, when intimately mixed with an animal substance, has some degree of antiseptic power; which agrees with the general theory concerning this power, as laid down in the third essay: For *saliva*, being an attracter of fixed air, when mixed with an animal substance, unites itself with the fixed air of that substance, and in this manner restrains, for some little time, the flight of the cementing principle.

† Sect. 4. No. 22.

EXPE-

EXPERIMENT 21.

As I could not, at this time, procure any fresh human bile, and excepting it were fresh, and taken from a healthy subject, the experiment would not have been fairly made, I was obliged to try that of a dog: One of these animals being therefore killed, and its gall-bladder taken out, about a drachm and a half of bile was found in the cyst.

ONE half of this quantity being mixed with three drachms of lime-water, the mixture remained transparent, and equable, for an hour; it then lost its pellucidity, and gradually deposited a light sediment, of dark yellow, or rather orange colour. When it had stood twenty-four hours, I passed the mixture through a filter, in order to separate the sediment; which being done, spirit of vitriol was poured on, and found to raise a slight degree of effervescence.

THE other half of the bile was put into a small phial, and air transferred into it from an effervescent mixture, as had been done in regard to the saliva, and then it

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was

was mixed with three or four drachms of lime-water.

THERE was very little difference between the appearances of this mixture, and those of the former ones: It remained transparent for about the same space of time, and then, like the other, lost its brightness by degrees, and deposited a sediment, which only differed in regard to the colour, being of a more light yellow. When this sediment was examined, after standing twenty-four hours, it was found to effervesce violently with the acid, whereas the ebullition of the other sediment was but obscure.

FROM these experiments (if the lime-water be a true test) we see, that *bile* contains somewhat more fixed air than *saliva*, and does not absorb this element so powerfully *.

AND here we plainly see in what sense these fluids are to be called saponaceous;

* As the *bile*, in a *sound state*, contains so little *fixed air*, we immediately see the reason why *putrid bile*, or the spirit distilled from it, raise little or no ebullition with *acids*, notwithstanding the other marks of the *alkali* in that fluid.

and may likewise comprehend in what manner they perform their action of dissolving fat, or oily matters: They *absorb* the *fixed air* from the oils exposed to their action, and thus destroying the bond of union between the oleose particles, render these bodies miscible with water.

AND hence the obvious reason, why the *saliva* should be the more powerful absorbent of the two; for had not the oily part of our food, from its admixture with the *saliva* in mastication, been rendered miscible with the watery part, the alimentary mixture could not have fermented properly when received into the stomach; the consequence of which would been sickness, nausea, and heartburning *, from the sharpness of the oil, now become rancid by the mere heat of the place.

BUT when all the discordant parts of the alimentary mixture are blended together, by the dissolvent power of the *saliva*, and further united by the same quality in the *succus gastricus*, *bile*, and *pancreatic*

* Not the heart-burning attended with acid, but that accompanied with nidorose, eructations.

juice *, then no separation of oil ensues, but the fermenting motion goes on, kindly and regularly, until new combinations take place, and that every particle of the food is broken and changed.

BUT in some constitutions this absorbent power of the digestive fluids is so greatly weakened (or, in other words, they contain much fixed air, when, in a natural and healthy state, they ought to contain very little), that the oily part of the food is never thoroughly mixed, or subdued; and hence the immediate cause of indigestion, cardialgia, rancidity in the stomach, and extraordinary flatulence.

AND possibly this might appear, upon examining the *saliva* of the patient, by mixing it with lime-water: If the mixture should immediately become turbid, and deposite a sediment that should effervesce on the addition of an acid spirit, it would shew the morbid state of the *saliva*, as

* Though neither the *succus gastricus*, nor *pancreaticus*, were tried, with relation to their containing fixed air, yet I apprehend that their similitude to the *saliva* will make it no unfair inference to say, that these fluids contain very little of this element.

containing

containing too great a proportion of fixed air, which must necessarily hinder the absorbent power of this fluid, and consequently disenable it from dissolving the oily part of the food.

I AM inclined to think, that this is actually the case in gouty subjects, where the complaints above-recited are constant forerunners, or attendants; and that the juices in these people are too much loaded with fixed air, which not only impairs the absorbent power of the digestive fluids, but also disposeth the earthy and saline particles of the blood, to run into concretions, which obstruct and tear the small vessels wherein they happen to be impacted.

IF this be the real condition of the fluids in gouty constitutions, lime-water, or the caustic alkali, would promise fair to be excellent *antarthritics*; and perhaps the benefits which accrue to patients, from the use of certain waters, may arise, in great measure, from these waters containing an earthy matter dissolved therein, void of *fixed air*, and which have an absorbent power, like what is observable in lime-water; which enables them not only

to help digestion, but also to dissolve, in some measure, the concretions that constitute the disease *.

THESE

* The Bath-water, which is found to give so much relief in gouty and nephritic cases, and in complaints of the stomach, arising from a weakness of the absorbent power in the digestive fluids, though perfectly limpid as it flows from the spring, yet presently deposits a large proportion of earthy matter, and is also said to grow turbid, and let fall a precipitate, on being mixed with an alkali.

If any person on the spot be desirous of knowing whether this earthy matter, which is dissolved in the water, be void of fixed air (like quick-lime dissolved in lime-water), or whether it be held in a state of dissolution, by the intervention of an acid, let him make the following trials.

1. Drop either *lixivium tartari*, or *spiritus cornu cervi per se*, into the Bath-water.

2. Drop either the *caustic alkaline ley*, made of *pot-ash* and *quick-lime*, or *spiritus salis ammoniaci cum calce viva*, into the same water; and observe whether it becomes equally turbid with the latter as with the former.

If it shall be found to do so, the experiments will shew that the earthy matter is dissolved in the water by the means of an *acid*; but if the precipitation shall be found to follow only from the mixture of the *mild alkalies*, and that the brightness of the water is not at all impaired by the addition of the *caustic*, then we may be assured,

THESE waters may be considered as a kind of natural lime-waters, containing a considerable portion of earthy matter, *void of fixed air* (like the particles of quick-lime dissolved in lime-water) which, as soon as the water comes into contact with bodies containing much of the cementing principle, this last is attracted by the earthy particles which thus acquire solidity, and form a succession of crusts, or layers; and it is in this manner that, I think, we may form a plausible theory for petrification *, and for the crusts that are found

assured, that the earthy matter is dissolved in *Bath-water* from being, some way or other, deprived of its *cementing principle*.

N. B. It will be necessary to try the *caustic* alkali with an *acid*, previous to the making of the experiments, in order to be certain that it is perfectly *non-effervescent*; that is, *void of fixed air*.

* A petrification that I have met with, since writing the above, seems to confirm this *hypothesis*.

It is a petrified moss, wherein may be observed, very distinctly, the several gradations from absolute stone to the living vegetable; the course of the fibres being every where plain, and easy to be traced. The part of the petrification that lay constantly under water

found in the pipes and vessels containing certain kinds of waters,

THESE

is absolute stone, and is of the calcareous kind, effervescing strongly with acids; in the middle part, which was not so continually exposed to the action of the water, the petrification is incomplete; and at the top, which was always above water, the vegetable is still alive, and in its natural state.

The well from whence this petrification was brought being in the neighbourhood of *Dublin*, I sent for some bottles of the water, in order to examine it.

On dropping a little of the filtered solution of *pot-ash* into a glass of the petrifying water, it immediately lost its brightness, turned milky, and, in a few hours, deposited a white sediment, which effervesced strongly with spirit of vitriol.

The very same appearances happened when *Lixivium Tartari* was dropt into the petrifying water.

On air being transferred into some ounces of the petrifying water, it lost its brightness, and, in twelve hours, let fall a small quantity of white sediment.

Hence it appeared, that the petrifying water did contain an earthy matter dissolved therein, void of fixed air, which was capable of resuming the solid form, as soon as the cementing principle was restored.

Vegetable bodies, therefore, by remaining long exposed to the action of such kinds of waters, will have their substance gradually dissolved; because the earthy particles in the water attract the fixed air from the ve-

THESE petrifying waters were formerly condemned, as being apt to create the stone, but later experience has shewn, that the waters which abound most in this earthy matter, and which from the greatest abundance of the crusts above-mentioned, are the most effectual dissolvents of the stone, as is every day experienced with regard to the *Carlsbadt* water in *Bobemia*.

THE absorbent quality of the *saliva* moreover shews, how apt it must be to lay hold of infectious *miasmata*, which oftentimes are in reality putrid vapours, or fixed

getable substance, and the moment they are saturated they acquire solidity, become insoluble, and remain in the places of the vegetable particles, which are melted away.

This change of a vegetable into a fossil substance, seems analogous to the change of iron into copper, which is brought about in no very long space of time, by leaving iron plates in a water that is strongly impregnated with a solution of copper in the vitriolic acid; the superior attraction of the acid to iron causing it to seize this metal, and let go the particles of copper. So, in the case of petrification, fixed air having a stronger affinity with calcareous earth than it has with the vegetable substance, lets go the latter, and seizeth on the former.

air,

air, detached from bodies during putrefaction; and confirms what hath been frequently recommended, namely, to shake off infection *, and prevent the *miasmata* from getting into the mass of fluids by immediate vomiting; and we may likewise see, that the cautions given by authors concerning the swallowing of the *saliva*, while in the places abounding with infectious vapours are founded in reason.

It will not appear strange that some of the animal fluids should contain so little fixed air, when we find that the *serum* of human blood seems almost void of this element.

EXPERIMENT 22.

HAVING ordered some ounces of human blood, drawn from a healthy person,

* By the precautions taken by Dr. Lind, and by immediate vomiting, “ only five persons died, from
“ among more than an hundred, who were severally,
“ and some of them constantly employed, during eighteen months, in various offices about the sick, in
“ *Häslar* hospital;” where there constantly was a great number of people ill of fevers that were highly infectious. See his *Discourse on Fevers and Infection*, paper 2d, p. 74.

to

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to be kept until the *serum* and *crassamentum* had fairly parted, I mixed two drachms of the serum with an ounce of lime-water: No change ensued; the mixture continued transparent, and, after forty-eight hours standing, no precipitate could be perceived, while the liquor remained in the glass; but, upon pouring it out, a very small quantity of white earthy matter was found at the bottom, which, however, would not effervesce with vinegar.

EXPERIMENT 23.

ABOUT two drachms of the *crassamentum* of the same blood being put into a cup with an ounce of lime-water, and left for five days, did neither totally dissolve, nor turn putrid; a piece of it being then taken out, and spirit of vitriol poured on, an effervescence ensued, the lime which had penetrated, and joined itself to the fixed air of the *crassamentum*, now bursting forth from every part of it, the moment the acid was applied.

So that the fixed air appears to be connected chiefly with the red globules, and with that part of the blood called by *Senac* the
the

the *lymphæ coagulabilis*; since these two are found to compose the *crassamentum* *.

EXPERIMENT 24.

Two ounces of lime-water being put into a tall drinking-glass, about half an ounce of blood was allowed to flow from the vein of a person in health, into the glass with the water: when it had stood six hours, the mixture was all poured out, to about a drachm, which was suffered to remain in the bottom of the glass; on this sediment some spirit of vitriol was dropped, and raised a smart ebullition, the calcareous matter turning white, as it boiled up on the addition of the acid; so that the fixed air, is easily detached from fresh blood.

* There was a very ingenious thesis published in 1762, by Dr. Butt, when he took his degree at *Edinburgh*; which contains a number of very satisfactory experiments and observations, concerning the component parts of the human blood. The title is *De Sanguinis Spontanea Separatione*.

EXPE-

EXPERIMENT 25.

NEW breast milk, when mixed with lime-water, in the proportion of one to three, in great measure destroyed the acrid taste of the lime, yet did not cause any separation that was immediately perceivable; but after standing twelve hours, the precipitation was visible, and, on pouring out the mixture, the sides of the glass were found incrusted with a calcareous matter, which, as well as what fell to the bottom, effervesced violently on the addition of spirit of vitriol.

So that milk contains a large proportion of fixed air, and consequently ought not to be mixed with lime-water, since it must necessarily take off from its activity.

DR. *Alston* observed very well, that there is scarce any thing that is usually mixed and given along with lime-water, that does not, more or less, destroy its efficacy; for which reason he recommended it always to be taken alone*.

* Dissertation on Quicklime, p. 41. sect. II.

LIME-WATER, when mixed with milk of any kind, prevents it from turning sour; the reason of which is obvious, because, by absorbing and retaining the fixed air, the intestine motion is prevented, whence there can be no change of combination.

I HAVE now finished what was originally proposed; and, I hope, have satisfactorily shewn, that *fixed air* is the *cementing principle*, and *immediate cause*, of *perfect* cohesion, at least in animal and vegetable bodies*; and though the experiments which I have made are very far from exhausting the subject, yet they certainly are sufficient to raise curiosity, and to prompt men of leisure to a further investigation of this important element;

* I have said *perfect* cohesion, for, as Dr. Hales observes, "Doubtless all the particles of matter what-ever do in actual contact cohere; yet since it is found
"by experiment, that the most solid parts of animals
"and vegetables yield a vastly greater quantity of air,
"and less water, than the more lax and fluid parts, it
"seems therefore hence reasonable to conclude, that
"their solidity is principally owing, not to the watery,
"but to the air and sulphureous particles." Vol. ii.
p. 280.

which ought not, by any means, to be confounded with the *atmospheric air*: for, excepting its being for a time capable of elasticity, the *fixed air* does not appear to agree, in any other property, with the *common air* which we breathe.

WE know for certain, that the *atmospheric* air could not immediately penetrate the body of the lime-water, or other fluids, in the manner that the *fixed air* plainly appeared to do: This last, though perfectly elastic when first set free, yet, in a very little time, loseth its spring, mixeth with the liquid, penetrates every where, and rusheth into union with the disunited and scattered particles of the substances dissolved*.

BUT

* The *air* which flies off from bodies, whether solid or fluid, in the exhausted receiver of an air-pump, is *not* the *fixed air*; for this never departs but when the body to which it belongs either suffers a decomposition, or is dissolving into minute parts.

Thus, if the *mild* volatile alcali, and the *caustic* volatile alcali (*viz.* Sp. cornu cervi per se, and Sp. Sal. Ammon. cum calce viva), be both inclosed in the same exhausted receiver, the one will throw off as many air-bubbles

BUT a still more striking distinction between the *fixed* and the *common atmospheric air*, may be remarked in the very different and opposite effects which the two produce in the bodies of living animals.

THE *fixed air*, when set free, and in a state of perfect elasticity, whether it be during the first stage of fermentation, by fire †, by effervescence, or by putrefaction, if it be received into the lungs of any living animal, causeth instant death.

BUT the same elastic matter, when received into the stomach, whether thrown off from effervescent mixtures, given in the way of medicine, or extricated from the food in the natural process of alimentary fermentation, is so far from producing any ill effect, that, in the first instance, it often operates like a charm in restraining vomitings, and, in the second, is

bubbles as the other; though we certainly know that the first contains a large proportion of fixed air, while the second is entirely void of this principle.

† Dr. Hales suffocated a sparrow, by putting it into air that had been obtained by distillation from heart of oak. Vol. I. p. 176.

absolutely

absolutely necessary for the support of life and health.

WITH regard to the *atmospheric air*, it is universally known that *no* animal can live long without fresh supplies of it, and those who have lungs cannot exist many minutes without taking in large quantities of this element. But if a very small portion of the same be forced into the vessels of any living animal, death presently ensues.

So that these two elements seem to be different in their natures, and to have quite distinct provinces with regard to animal life: It is required of the first, that it mix *wholly with* the blood; it seems sufficient that the second only communicate some subtile matter, or make *some impression upon* that fluid.

It must be confessed, however, that notwithstanding what hath been just now said, we have not, as yet, a sufficient number of facts to determine *positively*, whether these be *originally distinct elements* in nature; or whether the *fixed air* is nothing more than a portion of the *universal aerial fluid*, which is altered, and modified, from

its having been united with some other principle*.

It appears, however, from a circumstance peculiar to lime-water, that there is great store of the *cementing principle* always floating in the atmosphere, which is ready to be absorbed by such bodies as have an affinity therewith; for we see that the particles of the dissolved quick-lime, which are nearest the surface of the water,

* This seems to have been the opinion of Dr. Hales, who looked on fixed air as a portion of common, repellent, elastic air, deprived of its spring, and reduced to a state of fixity and attraction, by the power of the sulphur in bodies.

Dr. Cullen, if I am rightly informed, teacheth, that *phlogiston* is a compound, and holds fixed air to be one of its constituents.

Boerhaave was in some doubt what to think concerning the fixed air. “Dubitatum quandoque, an omne
“ illud quod ita gigneretur foret quidem ejusdem ita
“ naturæ ut eodem nomine aeris elastici appellari debet?
“ an vero, corpora certa lege resoluta in partes
“ minimas, omiſſa natura ſua prima, forte vera trans-
“ mutatione permutarentur in aerem hunc elasticum,
“ quidein rursus concretus aliis iterum firma redderet
“ nova corpora? an adeoque præter aerem communem
“ elasticum, aliud illi simile, non idem, in rerum
“ natura obtineret?” *Element. Chem.* tom. i. p. 532.

attract

attract the fixed air from the atmosphere, and form crusts, which are nothing more than the pure calcareous earth, such as the quick-lime was before calcination, and which, by the action of fire, may be again reduced to quick-lime.

AND the abundance of fixed air in the atmosphere may be still further proved, by its destroying the causticity and solubility of quick-lime, and by its rendering mild, and effervescent, the caustic alcalies, when these bodies are long exposed to the open air; and also by its action on living vegetables.

IT is universally known, that vegetables do not grow, or enjoy health, but in a free air; for as they are perpetually taking in some nourishing principle from the atmosphere, they require that this should be presented to them in a continual succession.

IT seems pretty evident, that this is the *cementing principle*, as these bodies are found, upon analysis, to contain a larger proportion thereof than can well be supposed is supplied by the roots, notwithstanding that there is found a good deal of fixed air in some kinds of soil.

THE fixed air resides principally, if not altogether, in the most elaborate part of the vegetable juice, the gum and the resin; and all bodies of the resinous kind, we have already seen, become soluble in water, when the cohesion of their particles is destroyed by withdrawing the fixed air: but as this method of solution * may be applied to many useful purposes in medicine, and perhaps in mechanics, it will not be amiss to lay down the several processes with a greater degree of accuracy and precision.

* Until within a few days before these papers were sent to the press, I looked on this method of dissolving resinous bodies as a discovery, not having observed, when I first read Dr. Lewis's *Materia Medica*, that the dissolvent power of quick-lime, with respect to these substances, is known to that ingenious and useful writer. The passage relating to this matter is under the head of *calx viva*, and runs in the following words.

“ Lime-water dissolves, by the assistance of heat,
 “ mineral sulphur, vegetable oils and resins, and animal fats; it extracts in the cold the virtues of sundry resinous and oily vegetables, and dissolves thick
 “ phlegm, or mucous matters, and the curd of milk,
 “ with which last it forms a white liquid, nearly similar to milk in its natural state.”

It

IT has been already mentioned, that the solutions made by the means of quick-lime, do all of them contain a certain proportion of the same; but as this may sometimes be reckoned injurious to the virtue of the medicine, *camphor*, and the several resinous bodies, may be dissolved in such manner as not to contain a single particle of quick-lime; as for example,

Take of camphor one drachm;

———— double-refined sugar one drachm;

———— simple lime-water one pint;

RUB the camphor and the sugar together into a fine powder, and then gradually pour on the lime-water; let the whole stand for two hours, and then pass the liquor through a filter. And thus will be produced, not indeed an intire solution, but a much stronger one than that in the common *julepum camphoratum*.

IN the common way of making the *julepum e moscho* (as directed in the London Dispensatory) scarce any of the *musk* is dissolved; but if it be made in lime-water, a perfect solution of the finer and more active part of the medicine will immediately take place.

Take of musk one scruple ;

———— double-refined sugar one drachm ;

———— lime-water six ounces ;

Rub the musk and the sugar together, then add the lime-water and filter, as before directed.

To this, as well as to the foregoing, the prescriber may add any spirituous water, or the volatile alkaline spirits, without destroying the transparency of the solution.

IN like manner may *scammony*, or *resin of jalap*, be dissolved ; and if some grains of *Jamaica pepper* be added, and rubbed up along with the sugar and other ingredients, it will communicate a most agreeable *cinnamon* flavour, that entirely covers the taste of the *jalap*, or *scammony*.

THESE solutions make very elegant and pleasant purging draughts ; only it must be remembered to order near triple the quantity of either the *resin* or the *scammony*, that would answer if given in substance ; for the resinous particles are so minutely divided in this sort of solution, that they give but a very gentle degree of irritation to the bowels.

Ir

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IF an acid spirit be poured upon what is left on the filter, after any one of the foregoing solutions, it will be found to raise a smart ebullition; which plainly shews that the quick-lime that was dissolved in the water is now saturated, and rendered solid, by the *cementing principle*, and has changed places with part of the resinous body, which remains dissolved in the water, while the lime is precipitated.

BUT there are cases wherein the lime will bid fair to improve the virtues of the resinous solutions; as, for instance, when the *cortex* is prescribed merely with a view to its astringent quality, as in scrophulous and relaxed habits, in order to check or dry up ulcers, gleet, or uterine discharge; and here it may be ordered in the following manner:

Take of Peruvian bark, in powder, two ounces;

———— quick-lime one ounce;

———— lime-water thirty ounces;

RUB the bark and the lime together, until they be thoroughly mixed; then gradually pour on the lime-water; let the whole stand for twelve hours, and then pass the liquor through a filter.

AND thus will be obtained a most elegant, and not unpalatable tincture, which may be taken, either quite alone, or in any convenient vehicle, and in what quantity the prescriber shall judge proper.

I CAN venture to assure the reader, from experience, that the bark, given in this manner, and in the cases above-mentioned, produceth excellent effects. And where a yet stronger astringent is required, oak-bark, managed in like manner, has been found to answer exceedingly well.

RHUBARB, prepared in the same manner, yields a beautiful tincture, which promiseth to be of great service in all cases where small quantities of this root are given with a view to strengthen the bowels, and to preserve them free from a load of viscid slime, as in weak and ricketty children.

ALOES, when joined with the lime, is not near so nauseous as when dissolved in the common way; and therefore independent of the lime, whose virtues, as an anthelminthic, are considerable, bids fair to be of great use; for children, who generally are the patients in these cases, will probably

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probably be induced to take the medicine better when thus made up, than when it is prepared in the usual manner.

MYRRH and *saffron* may be occasionally joined with *aloes*; and being all dissolved by the means of quick-lime, will make an efficacious *elixir proprietatis*, as the lime will certainly improve the virtues of the other ingredients, in most cases where a composition of this sort may be ordered to advantage.

GUM GUAICUM dissolves very completely, in the manner we are now speaking of, being rubbed up with an equal quantity of quick-lime, and afterwards mixed with the requisite quantity of lime-water; and perhaps may be found a more powerful medicine, in cold rheumatic complaints, than the common tinctures: I have not, indeed, made trial of it; but I find that *castor* answers exceedingly well, given in this manner, and may be taken in large doses, without offending the stomach.

Two drachms of *castor*, rubbed up with a drachm of quick-lime, and mixed with six ounces of lime-water, give a strong and elegant tincture, which may be flavoured
by

by adding nutmeg-water, or any other of the like sort, and then given in doses of two or three spoonfuls, as often as shall be thought convenient.

It will, no doubt, be reckoned superfluous, that *lime-water* is ordered to be added to these several substances, when they are also to be rubbed along with *quick-lime*; but the reason is this: If the lime were so quick and fresh as to raise heat when common water is poured on it, the solution might then be made without the aid of lime-water; but as it will, for the most part, happen that the lime kept in the shops will not be perfectly fresh, it will be best that the prescriber should direct lime-water to be used, in order to be secure of the solution, which would not be so completely made, nor so much of the resinous substance be dissolved, if *slacked lime* and *common water* only were made use of.

AND it is much the same thing in the end, with regard to the proportion of lime in the solution; for although lime-water may receive some additional strength, from being poured repeatedly on fresh quick-lime

lime (as Dr *Whytt* and Dr. *Home* * insist, in opposition to Dr. *Alston*), yet here the quantity acquired must be so very inconsiderable as not to be worthy of notice.

* See Dr. *Whytt*'s paper on this subject, in the first volume of the *Edinburgh Physical and Literary Essays*, and Dr. *Home*'s experiments on bleaching. In the last-mentioned book (which I had not read when I made my experiments), I have the pleasure to find many things perfectly coincide with, and confirm, as well the general theory laid down in the foregoing essays, as what relates particularly to the antiseptic power, and to the nature of petrifying waters.

F I N I S.

desirable as not to be worthy of notice.

[illegible]

E R R A T A.

Page line

- | | | |
|-----|----|--|
| 27 | 4 | instead of <i>from</i> read <i>by</i> . |
| 72 | 4 | for <i>arrive</i> read <i>arise</i> . |
| 94 | 12 | for <i>nor</i> read <i>on</i> . |
| 144 | 19 | dele <i>as</i> . |
| 146 | 14 | read (figure) 2 instead of 11. |
| 176 | 3 | read <i>in</i> instead of <i>of</i> . |
| 219 | 12 | for <i>yellowing</i> read <i>yellowish</i> . |
| 256 | 10 | read <i>putrefaction</i> . |

Page—Line

- | | | |
|-----|---------------|--|
| 94 | 12 | for <i>nor</i> , read <i>on</i> . |
| 171 | (in the note) | for <i>blood's fibres</i> , r. <i>blood and fibres</i> . |
| 172 | 5 | for <i>these</i> , r. <i>there</i> . |
| 174 | 20 | for <i>any</i> , r. <i>every</i> . |
| 220 | 4 | for <i>latter</i> , r. <i>natural</i> . |
| 223 | 9 | for <i>appearing</i> , r. <i>enabling the water</i> . |
| 249 | 5 | for <i>from</i> , r. <i>form</i> . |

Beside the following, which do not so much affect the sense.

Page 1, line 3, read *transmutations*. p. 160, l. 8, r. *perspiration*. p. 176, l. 3, for *of*, r. *in*. p. 227, l. 21, for *drank*, r. *drunk*. p. 138, in the note, r. *kinds*. p. 142, l. 5, for *ones*, r. *one*.

And in the first figure, the engraver has committed a very great mistake, by *not* representing the *Cylindrical Glass C*, as *inverted*.

ERRATA.

20	read for 'the'.	20
21	for 'the' read 'the'.	21
22	read 'the' instead of 'the'.	22
23	for 'the' read 'the'.	23
24	for 'the' read 'the'.	24
25	for 'the' read 'the'.	25
26	for 'the' read 'the'.	26
27	for 'the' read 'the'.	27
28	for 'the' read 'the'.	28
29	for 'the' read 'the'.	29
30	for 'the' read 'the'.	30

P O S T S C R I P T.

AS I had neglected looking into the third edition of Dr. Pringle's book, until the foregoing sheets were all printed off, I have not now an opportunity of correcting myself with regard to a passage in the second essay; where I have introduced the doctor as saying, that putrid animal substances are not to be regarded as alkaline. This I had taken from the second edition; but I should certainly have expressed myself in other terms, had I then known that Dr. Pringle has, with that candour which is inseparable from the scholar and the gentleman, altered his opinion concerning this matter, in consequence of some experiments made by M. Gaber at Turin,

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